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DWIGHT H. GREEN, Governor

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ADDRESS OF THE PRESIDENT

THE BIOLOGICAL BASIS OF SOCIAL COOPERATION

ALFRED E. EMERSON
The University of Chicago
President, Illinois State Academy of Science, 1945-1946

Within the life-time of many of us, the human mind has been shocked by two world wars. Natural scientists are being blamed for the increased intensity and appalling destructiveness of military weapons. The fury of explosives and fire has overwhelmed civilian areas as well as military targets. Even before the advent of the atomic bomb, the annihilation of cultural accumulations and the death and paralyzing misery that man wreaked upon man was stupendous. A future atomic war will surely destroy our civilization and stop human progress for decades if not for centuries. Is it any wonder that the popular mind is concentrating more upon the destructive phases of scientific knowledge and less upon the life-saving, and inspiring advances of scientific discoveries?

Few believe it possible to construct a world government devoted to the well-being of all mankind before rival nations succeed in destroying each other. This pessimism is partly based upon a lack of confidence in the efficacy of traditional diplomacy and statesmanship, partly upon the apparent amoral ingenuity of the natural scientists, and partly upon the conviction that there is an innate principle in human nature or in the universe that drives man inevitably toward national, racial, and class warfare. Man's inborn aggressiveness, the struggle for existence, the survival of the fittest, "nature red in tooth and claw," the "law of the jungle"—all are used to rationalize our failure to attain world peace and security.

The importance of the biological basis of society has been debated. It is also probably an open question whether an intelligent and scientific discussion of the biological factors can in any way influence our political emotionalism. I am of the opinion that, among others, biological factors exert important social influences. Sex, family, and such basic aspects of social integration as the dominance of the top individuals in the social hierarchy antedate the emergence of *Homo sapiens*. Competition, cooperation, and selection have influenced the evolution of these lower population levels and are likewise still affecting the societal evolution of modern man.

I am going upon the assumption that man is a rational rather than merely a rationalizing animal, that intelligence—especially that based upon scientific knowledge—has been and in the future may be used as a guide for social evolution, and that it is one of our immediate objectives to correct social thinking based upon scientifically fallacious concepts. Scientists engaged in teaching, particularly teachers in high schools, colleges and universities, have both the opportunity and the privilege of assisting in the formation of a scien-

tifically sound social philosophy, and in this moment of great global peril, it behooves us to direct our combined efforts in this direction. Once the guiding principles become clear, it is also our duty as citizens to take political action in whatever way becomes possible. Scientists have traditionally avoided mixing their objective laboratory or field studies with their admittedly subjective political opinions. Recent events, however, prove that scientists are immersed in politics whether they like it or not. Instead of avoiding the problem, let us attempt to raise the quality of our social thinking to an approximation of our scientific logic. Let the natural and the social scientists work together toward this end. Democracy is dependent upon an informed and broadly intelligent electorate.

Have scientists formulated guiding principles applicable to social evolution? Many natural scientists have spoken on social problems, and in numerous cases these pronouncements are not considered valid. For example, I recently read an address by the Chancellor of the University of Munich given a decade ago justifying Nazi ideology through biological rationalization. There is always a danger that emotionalism may outweigh scientific logic, particularly in the analysis of human affairs. Let us be explicit in recognizing and evaluating our biases. None of us are infallible, but truth tends to survive error.

Conflict and cooperation are both apparent in human society. Conflict and competition have both constructive and destructive aspects, and cooperation may lend itself to destructive exploitation. What is the biological background for these social manifestations? I think that it can be demonstrated that competition and cooperation are attributes of organization and are as truly characteristic of life as is protoplasm itself. Known natural forces guide living systems away from destructive competition toward toleration, integration, and cooperation. Once such a principle is established, the scientist as such may not be in a philosophical position to state what ought to be done; but he can predict to a certain extent the consequences of our failure to conform to natural law. As a human, the scientist has as much right to make moral judgments as any other individual, and it seems to me quite possible to harmonize our scientific and our ethical thinking.

The concept of cooperation at first sight would seem to be at variance with our usual picture of the relations of organisms in the sea, forest, or desert. These ecological communities, however, are in the process of being carefully investigated and certain generalizations are beginning to emerge. We find much orderability in the community that indicates the existence of an interspecies level of biological integration. Quantitative gradients of a variety of environmental factors order the system in numerous directions. These gradients in turn establish thresholds of survival that result in a qualitative differential between parts of the system.

As an example, the edge of a forest has more light close to the ground than in the deep woods; there are greater extremes of temperature at the edge than in the middle; there is greater evaporation at the borders; and there is likewise greater air movement. With such contrasts in physical factors goes a quantitave difference in the abundance of many species of organisms including the food-producing plants, the plant-eaters among the animals, and the scavengers, predators, and parasites in the complex food-web.

When the quantitative change in the abundance of any given species reaches zero, a qualitative change of species in the system occurs and gross changes in the interdependent relationships ensue. Not only do gradients occur from the borders toward the interior, but striking variables are found from the forest canopy to the subterranean level resulting in stratification; gradations occur from low-lying swamp forests to well-drained upland forests, from temperate to tropical forests, from island to continental forests, from sandy to clay soils, and from acid to alkaline soils.

Not only do we find gradations giving spatial organization, but we also find temporal sequences. In the Indiana dunes on the shore of Lake Michigan, poplars are replaced in time by pines, pines give way to oaks, and oaks are succeeded by the climax beech-maple forest. The earlier stages of this succession produce conditions that result in the further development of the community. For example, the accumulation of humus in the soil with consequent lessening of the evaporation of moisture gradually eliminates the species adjusted to dry conditions and allows the survival of species adjusted to more moist conditions. The earlier stages of succession are not self-perpetuating, but the climax forest becomes stable and self-perpetuating together with all its dependent organisms.

The development of the community through these temporal stages involves several directional trends. In the early stages, the number of species are few, their environmental conditions fluctuate more widely, and the elimination of individuals and species by physical extremes is more prevalent. In the climax community, the environmental fluctuations are less extreme, the conditions are favorable for more species, the interrelations become more complex, and there is a greater biotic interdependence. In the earlier successional stages, survival depends more upon the adjustment to severe physical conditions. In the mature community, survival depends more upon the adjustment of the species to the other living organisms. Organisms in both the early and simpler as well as in the late and complex stages of community development have to be adjusted to both physical and biotic conditions, but the number of ecological niches increases in the later stages of community development and the biotic factors increase markedly in complexity as the physical factors become more uniform, more stable, and more optimal.

Within these complexes we find species in conflict and competition, species that tolerate each other and live side by side, and species that survive through mutualistic and reciprocal benefit. These relationships set up survival values that sort a large number of genetic variables, thus giving rise to selection pressures that move the whole assemblage along another temporal dimension that is termed organic evolution.

For the purpose of this discussion, I am grouping the various interspecies relationships into four categories—mutual harm or disoperation, unilateral benefit including much conflict and competition, mutual harmlessness or toleration, and mutual benefit or cooperation. Because of selection pressure, these categories have a certain evolutionary order in some cases.

There may be every gradation between these categories, and classification may be quite confused at times. A species may be harmful to another species at one stage in its life cycle and beneficial at another. The activities such as feeding, defense,

and reproduction may vary in their beneficial and harmful effects upon other species. However, it is possible to demonstrate that these categories have more than a mere formal order.

Cases of mutual harm are hard to find in nature and the reason is clear. As an example, a lighthouse-keeper on a small island found introduced rabbits eating his vegetable garden. He brought in cats to control the rabbits. The cats ate every rabbit on the island and then starved to death as there was no other available food. The relationship of cats to rabbits was thus mutually harmful. Such a relationship eliminates itself and is usually found only when man has brought unadapted species together or otherwise drastically upset the balance of nature. The Chestnut Blight introduced by man from the orient eliminated the Chestnut tree from our eastern deciduous forests. With the death of the host, the fungus also lost its main food supply. The oriental chestnut, however, has not been eliminated by the Chestnut Blight in its original home and the fungus is also more successful. We may thus state that disoperation is more likely when two species come in contact for the first time and have no common evolutionary history within the same community. Cases of drastic disoperation are not easily found in nature because of the obvious selection against such relationships.

Unilateral benefit including much conflict and competition is a major aspect of community relationships. Some environmental necessities are in superabundance, and species are not in conflict or competition as they acquire what they need. On the other hand, many necessities are in limited amounts insufficient for all, and the struggle of acquisition sets up strong selection pressures. Selection for more efficient predation may direct the evolution of a predator, but such an advantage increases the selection pressure toward more efficient escape mechanisms of the prey, thus tending to balance the relationship. A balance between predator and prey may be reached immediately without evolution. For instance, a food species that is increasing may bring about an increase in the predator or parasite that in turn decreases the food species and thus decreases the number of predators or parasites. Both species will thus fluctuate periodically up and down from the mean population density. This is a form of equilibrium found in nature, but we must not forget that such a relationship sets up selection pressures that in turn result in an evolutionary movement toward better and better predatory devices and better and better escape mechanisms. Consequently a certain balance is maintained in time in spite of the evolutionary progression of the competitive system.

The evolutionary advance of large numbers of species with interdependent relationships of great complexity gives rise to community organization expressed in such terms as the web of life, the food-chain, and the pyramid of numbers. Such integrations are characteristic of very different communities—for example, those of the open sea and tropical continental regions.

It should be recognized, however, that there is an evolutionary movement away from drastic conflict and eliminative competition toward more tolerable relationships. At first sight this directional change is not always apparent, particularly if one focuses upon the individual and not upon the population. For example, an individual puma may be in conflict with an individual deer with a resulting unilateral benefit to the

puma. It so happened that, in the Kaibab forest of Arizona, man had "altruistic" regard for the deer because he wished to do the killing of the deer himself. He therefore "saved" the deer by eliminating the pumas. The result was that the deer increased in numbers, could not survive on the limited winter food supply, and died by the thousands. Consequently there was a smaller population of deer than there would have been had man let the puma alone. It is easy to see that what may be a one-sided harmful relation between individuals may be a tolerable or even beneficial relation between populations. Let us also not forget that it is in large measure the populations that are the units of evolutionary change, as has been emphasized by Sewall Wright.

A predator may be better off if it has a diversity of food sources, and this may also be better for the prey species. If efficiency of predation results in specialization on a single food species, the predator is in a somewhat precarious position as far as survival is concerned. Thus we find the whole ecological community tends to move toward balanced interrelations, the parts (or species) guided in large measure by the system as a whole. The whole community tends to attain a relative equilibrium sufficient to carry the quantitative pattern through long periods of time. Competition is maintained at the optimum, and either too much or too little may be deleterious. Optimal competition is the counterpoint in the harmony of nature.

When man upsets the balance of nature, it is often necessary for him to reestablish the balance. About 1900, the sugar-cane leaf hopper was introduced into the Hawaiian Islands and soon afterwards came close to wiping out the sugar industry. The leaf hopper was later found to be native to Australia where the species was neither common nor considered a pest. Parasites and predators were introduced into Hawaii and were so effective in controlling the leaf hopper that it is no longer a serious pest in the islands.

Through the analysis of the relative pathogenicity of ancient parasites in comparison to more recent infections, Clay Huff has recently illustrated the tendency of organisms to evolve from unilateral harm toward mutual toleration. Parasites such as rickettsias, spirochaetes, haemoflagellates and malarial protozoa show much greater pathogenicity in the more recently acquired host and less in the more ancient host. There would seem to be a marked tendency for the hosts to evolve physiological toleration of the parasites and the parasites to evolve away from dramatic elimination of the hosts.

Balance may be the result of opposing competitive pressures without reciprocal adaptation. However, the evidence points to an evolutionary development of balance between populations of different species in some cases at least, to some degree similar to the phylogenetic development of balance in the evolution of organisms and populations of a single species.

With the pronounced tendency of organisms to evolve toward balanced equilibrium and toleration within the ecological community, one would suppose that cooperation between species would be the final chapter in community evolution. Among the generally cited cases of mutual benefit between species may be mentioned the nitrogen-fixing bacteria and their legume hosts, the relation of fungus and alga in the lichen, bacterial intracellular symbiotes, cellulose-digesting

flagellates in the intestines of wood-eating roaches and termites, mycorrhizal association of plant roots and fungus mycelia, algae in the tissues of multicellular animals, seed dispersal through fruits attractive to birds and mammals, flower pollination by insects, the cultivation of fungi by certain ants and termites, and the so-called guests of social insects. Added to these are the more recent evolution of plants and animals under domestication by man.

Without going into the details of these mutualistic relations, it is possible to show that a reciprocal adaptation has occurred in many cases leading to interdependence. In a number of instances the symbiote is of as much importance to the host as one of its own tissues or organs, thus establishing an interspecies system strikingly like that of an organism.

Although cooperation does occur in the community, it is noteworthy that it is not nearly as common as one might postulate on theoretical grounds. Many of the cases of mutualism are not strong cases. For example, I know of no evidence to prove that the alga in the lichen association has undergone any evolutionary adaptation to the fungus. Also there is no well-established evidence that the legume has evolved adaptations for harboring nitrogen-fixing bacteria. Mutual adaptation occurs between the termites and their intestinal cellulose-digesting flagellates, but only the primitive termites harbor the protozoa while the derived termites constituting three-fourths of the known species have lost the protozoa and digest their cellulose without symbiotes. One might ask why, if mutualism were the end of evolution, did the termites become so successful after they lost their symbiotic protozoa.

If one examines any one of the large complex ecological communities, one has to hunt for cases of mutualism whereas competition is obvious everywhere one turns. With the exception of flower-pollinating insects, one may even have to travel to remote portions of the world to find certain especially good examples of mutualistic adaptation. Even in the case of insect flower-pollination, found in all terrestrial communities, an analysis of the food habits of over 15,000 species of insects in New York State showed that 75% were predominantly competitive, 23% were predominantly tolerative, and only 2% were mutualistic.

Turning now to the relations within the organism and within species populations, there would seem to be little doubt that cooperation is the successful and dominant adjustment. Cooperation is characteristic between protoplasms in the cell, between cells in the multicellular organism, and between individuals in the majority of aggregations and coordinated animal societies.

No one seems to seriously question the reality of the individual as a biological entity nor to question the fact that the individual is a naturally selected unit. Much controversy, however, still rages over the unity of the intraspecies population. The evolution of the sterile castes in the social insects was explained by Darwin through the selection of the "family" as a whole. Weismann used similar data to show the selection of the "state" as a unit. The social insects are by no means the only coordinated populations. Various gradations of integration occur in aggregated populations from protozoa to man (Allee). The species itself is a population unit basically integrated through hereditary transmission. If selection were acting alone to preserve the fit individual, how would the elaborate adaptations for reproduction have come into existence?

How would sexual adaptation have arisen? By what means would mammals have evolved mammary glands for the nourishment of their progeny? How would a sterile worker ant have evolved? Patently the species is a population unit selected as a whole. Because of the survival or elimination of whole population systems, cooperation between the individuals has evolved. Thus the sacrifice of the individual for the benefit of the whole species may occur and may be understood in both human society and in groups of lower organisms. Just as the cell in the body functions for the benefit of the whole organism, so does the individual organism become subordinate to the population. It is in harmony with natural law to have an individual function for the benefit of other contemporary individuals and also for future generations. This principle gives us a scientific basis for ethics.

Cooperation is probably not an end in itself, but is rather a means to an end. The all-over directional trend in organic evolution seems to have been toward optimum conditions for existence. What was the uncontrolled external environment of the cell became the balanced internal environment of the multicellular organism. Selection of variations lead toward more efficient division of labor and more integration and cooperation between the parts. Differentiation would be useless without integration, and integration would be useless without differentiation. Natural selection has constantly guided organic evolution in the direction of increasing complexity and increasing cooperation. This trend is easily seen in the study of the evolution of intraspecies populations and reaches its culmination in the social insects and in man.

What biological principles emerge from these considerations? A few may be listed.

1. The intraspecies population and the interspecies community exhibit integration in space, development in time, and evolution in time.
2. Development as well as evolution is in the direction of less extreme environmental fluctuations, more optimal conditions, and a more complex relationship between larger numbers of parts.
3. A long-term relative dynamic equilibrium is established in both the population and the community paralleling that in the individual organism (homeostasis).
4. Evolutionary mechanisms tend to guide the evolving system away from harmful relations toward toleration and cooperation.
5. Each individual is a part of a m o r e comprehensive population unit.
6. Each species is a part of an interdependent community with organismic characteristics.
7. The interspecies system is less definite and more loosely knit than the intraspecies system with its germinal continuity.
8. Cooperation is more characteristic and has been carried to a further degree in the organism and in the intraspecies population than in the interspecies community, but it has evolved in all systems.

Do any of these principles have validity in building a social philosophy?

Man, including all races, is one species. At one time isolation produced divergence that if continued would probably have led to a number of distinct species. However, with the increasing development of transportation and communication, the trend is now toward fusion, cohesion, and species consciousness.

What has recently happened to the people of Manchuria, Abyssinia or Poland has greatly influenced the the lives of us all, a fact that dramatically illustrates the interdependence and integration of all mankind. In spite of much destructive conflict, the human species is already integrated through migration, communication, transportation, economies, politics, religion, culture, health, and science. Conflict may be sublimated and controlled in the interests of peace, well-being, and progress. It seems safe to predict that the immediate future will witness much greater coordination.

Diversity of culture is not incompatible with world integration. Cells became more diverse in function as they evolved in a multicellular organism. Species became more numerous as the complex ecological community evolved. Human individuals and cultural groups may be expected to exhibit greater functional variation as they become incorporated into a world society. Selection acts both upon the parts separately as well as upon the whole unit. A certain degree of healthy competition between nations, races, denominations, classes, and institutions may speed progressive social evolution, but present destructive conflict is often deleterious to the world society and to the conflicting organizations.

While recognizing biological parallels, we must also give due weight to the differences between human society and biological systems. Both are doubtless evolving and both are being guided in this evolution along certain perceivable directions, but the evolutionary mechanisms are markedly different as well as markedly similar in the two systems. Human social evolution, through the development of transmissable symbols, has been able to move rapidly from the primitive social systems to high culture and civilization without waiting for the natural selection of mutant genes in the chromosomes. However, there is a social non-germinal heredity that may be compared to biological heredity, and a selection of social variables sorts out the more fit cultural relations for social survival. Also, an intelligent analysis of the factors and synthesis of the principles enables man to control his own rapid evolution and that of his cultivated plants and animals far more efficiently than was possible in the pre-human world. Organic evolution and much social evolution have been largely unconscious, but man's superior intellect enables him to consciously direct his societal evolution. To the survival values of the biological world, man adds the appreciative values that integrate his culture.

Let us frankly recognize and evaluate the differences between the biological and human systems, but let us also not be blind to the similarities. In both, long-term efficiencies may gain ascendency over short-term efficiencies because it is the temporal population that is the unit of selection.

Survival, especially in human social evolution, does not necessarily involve the death of the eliminated. Through the evolution of the capacity to learn from experience, harmful behavior patterns may be suppressed and beneficial patterns developed in the same individual or in the same group. Depending upon long-term benefits to the species as a whole, communism might win or lose in its competition with capitalism without bloodshed. Possibly the better aspects of both social systems may be incorporated harmoniously in a future society through the operation of social selection akin to natural selection.

We cannot settle social problems wholly by recourse to biology. Biologists as such have little detailed advice to offer in building political and social organizations. However, biology may clarify certain fundamental principles that underlie our social behavior and may assist in giving a foundation for a general understanding of the social superstructure.

The formulation of principles has great value, but each principle must be incorporated into our social philosophy in its adjusted niche. "I have often thought," wrote Liebig to his friend Duclaux, "in my long and practical career and at my age (69 years) how much pains and how many researches are necessary to probe to the depths a rather complicated phenomenon. The greatest difficulty comes from the fact that we are too much accustomed to attribute to a single cause that which is the product of several, and the majority of our controversies come from that."

Oversimplification is an error often committed by scientists in their drive to discover basic principles that relate diverse facts. If the terms are general enough to incorporate complex phenomena, they are likely to be ambiguous. Nevertheless on occasion fundamental principles may be stated in language that has meaning to most listeners and in a manner that brings orderability to vast accumulations of knowledge. We may thus be emboldened to summarize our main conclusions concerning biological and human relations. (1) Optimal competitive relations survive and too little or too much competition is eliminated through selection. (2) The probability of survival of individual, or groups of, living things increases with the degree with which they harmoniously adjust themselves to each other and to their environment (Leake). (3) A directional trend in evolution is toward a controlled balance of the important factors within the system. Human society cooperatively brings the social environment under control for the better survival of the species.

If these conclusions are based upon sound evidence and are scientifically valid, we may expect that destructive class, racial, and national war will be largely eliminated. Biology indicates that exploitation of individuals or groups within a population will be superceded by toleration and cooperation. Forces are apparent that are guiding us toward an interdependent world unity. This is not a philosophy of perfectionism. Perfection is probably only in the minds of philosophers. Biology gives us no example of perfection—only an evolution toward a better relationship between parts of a larger whole.

With the advent of the atomic bomb, will the human species become cooperative under some sort of a world government soon enough? This is a question that must be deferred to the social scientists and politicians who must carry the burden of discovering adequate social means for eliminating war. It is now apparent to many that treaties between sovereign nations with exaggerated nationalistic ideologies are insufficient to prevent catastrophe in our own lifetime. The dramatic and terrible potentialities of our present military weapons are in the process of revolutionizing our international thinking. Will such thinking based upon realistic fear of social suicide spur us into effective political and diplomatic action? Can an aroused public force our political leaders to solve this problem and solve it quickly? The issue is clear —it is cooperation or vaporization.

It is a struggle for existence by means of the cooperation of all mankind, or extinction through unnatural destructive competition between individuals, classes, races, and nations already incorporated into a larger interdependent whole. Following the seemingly impossible accomplishments of the natural scientists, can the politicians also accomplish the seemingly impossible? Can the inspiring advancement of natural and social science be directed to the welfare of all mankind? With the development of an energetic public pressure, there is a basis for optimism.

AGRICULTURE

EFFECT OF SOIL TREATMENT ON FORAGE YIELDS AND VEGETATIONAL GROUND COVER

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Vegetational response to soil treatments can be measured by a number of different methods. Yield of dry matter is a conventional method usually employed; however, the yield from a given area does not provide a measure of the contribution of individual species to the total, nor does it indicate the percentages of weeds and other undesirable species present. Separation of species by manual methods is tedious and expensive. Because of this, much valuable data is lost, particularly as it relates to the effect of fertilizer materials on the occurrence of species in a turf.

Some two decades ago the point quadrat method was (1) introduced as a machine for measuring ground cover. Although it is not suited for use with tall vegetation, it does have a distinct place in making measurements on pastures and other types of turf. The point quadrat (Fig. 1) provides a rapid method of measuring the botanical composition of vegetation. It does not measure yields in terms of grams or pounds, although some recent work by Arny et al (2) using a series of factors did indicate that the point quadrat could be used to give both a measure of yield and botanical composition.

The data presented in this paper were obtained in 1940 and 1941 from a series of plots at the University of Illinois Soil Experiment Field located at Elizabethtown, Illinois, in Hardin County.

MATERIALS AND METHODS

Five plots approximately 1 x 9 rods in area were seeded on September 18, 1935. Fertilizer materials and limestone were applied, crossing the seeding mixture plots. Each seeding-mixture-soil-treatment plot was one rod square.

The fertilizer materials and limestone and the annual application per acre, excepting limestone which was applied in sufficient quantity to correct acidity, were as follows:

Plot 1= 250 pounds of rock phosphate
150 pounds of sodium nitrate
Plot 2= 200 pounds of superphosphate—20 percent
150 pounds of sodium nitrate
Plot 3= 250 pounds of rock phosphate
Plot 4= 200 pounds of superphosphate—20 percent
Plot 5= 75 pounds of 9-27-9 fertilizer
Plot 6= No treatment
Plot 7=4000 pounds of limestone
Plot 8= 250 pounds of 0-24-12 fertilizer
Plot 9=4000 pounds of manure

The seeding mixtures and the acre rates of application were:

Mixture No.1=	
Kentucky bluegrass	8 pounds
Redtop	5 pounds
White clover	3 pounds
Alsike clover	3 pounds
Mixture No. 2=	
Kentucky bluegrass	8 pounds
White clover	3 pounds
Bermuda grass	6 pounds
Korean lespedeza	5 pounds.

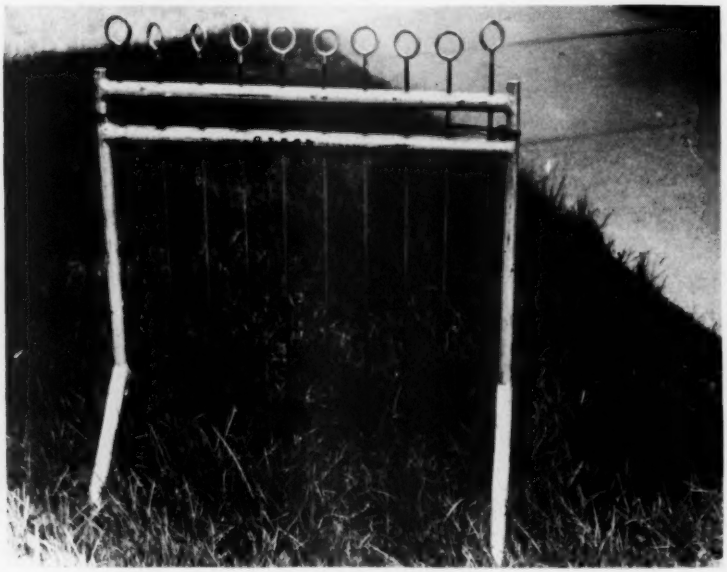

FIG. 1.—The point quadrat.

Mixture No. 3=	
Timothy	8 pounds
Redtop	4 pounds
Red clover	4 pounds
Korean lespedeza	4 pounds
Mixture No. 4.=	
Orchard grass	6 pounds
Kentucky bluegrass	3 pounds
Redtop	3 pounds
White clover	4 pounds
Korean lespedeza	4 pounds
Mixture No. 5=	
Kentucky bluegrass	8 pounds
White clover	3 pounds
Timothy	5 pounds
White sweet clover (*Melilotus alba*)	4 pounds

All fertilizers were applied beginning in 1931. The first seedings were made in 1931 and 1932. As indicated previously, new seedings were made in 1935. The data reported in this paper are for the years 1940 and 1941.

Hay yields were obtained by sampling each soil-treatment plot (with a small quadrat) twice during each season, usually early in June and again in August. Point quadrat readings were made before either the first cutting or followed the second cutting of hay or both.

RESULTS—YIELD DATA

Yields of air-dry hay for the seasons of 1940 and 1941 are given in Table 1. The relationship between seed mixtures and soil treatment is marked excepting seed mixture No. 1 which contained no lespedeza, timothy, or sweet clover. In 1940, a good season for tall growing grass species, large yields were obtained with few exceptions. In 1941, the yields were greatly reduced. This reduction was presumably caused by lack of moisture. When moisture is deficient, plants are unable to utilize fertilizer materials applied to the soil. Instead of stimulating growth these materials apparently have a drepressing effect. Where no soil treatment

TABLE 1.—HAY YIELDS FROM SOIL-TREATMENT—SEED MIXTURE PLOTS FOR YEARS OF 1940-1941
(Totals for Two Years)

Plot	Mixture No. 1 lbs./A	Mixture No. 2 lbs./A	Mixture No. 3 lbs./A	Mixture No. 4 lbs./A	Mixture No. 5 lbs./A
1	1940—1200	4684	7069	6961	6746
	1941—1008	974	1133	600	773
	2208	5658	8202	7561	7519
2	1940—1400	2726	6422	937	7186
	1941—1008	974	1133	1200	1030
	2408	3700	7555	2137	8216
3	1940—1754	703	636	1190	7560
	1941— 336	650	1416	600	773
	2090	1353	2052	1790	8333
4	1940—1741	904	2752	1361	7274
	1941— 672	650	850	600	1030
	2413	1554	3602	1961	8304
5	1940—2222	1194	2377	2740	4768
	1941— 336	650	1133	600	1803
	2558	1844	3510	3340	6571
6	1940—1182	268	408	302	1624
	1941— 672	650	1133	1200	1288
	1854	918	1541	1502	2912
7	1940—1195	326	1840	6665	2754
	1941— 672	650	1416	2100	1288
	1867	976	3256	8765	4042
8	1940—1285	3344	4786	3638	5892
	1941—1008	974	1416	1200	2061
	2293	4318	6202	4838	7953
9	1940—1416	504	3742	3052	2318
	1941— 672	1299	1416	1800	2318
	2088	1803	5158	4852	4636

has been applied (Plot 6) the yield depressions did not take place.

POINT QUADRAT DETERMINATIONS

Although a number of point quadrat determinations were made, only two sets of data are included. These data are indicative of the vegetational cover. Tables 2 and 3 give quadrat data obtained in November 1940 and August 1941. One hundred point readings were made on each plot on each date.

Native grasses consisted of *Paspalum, Panicum,* and *Digitaria* sp. Some *Andropogon virginicus* (broomsedge) occurred on the lime and no treatment plots. Dominant weed species were *Plantago lanceolata, Rumex acetosella, Diodia teres, Taraxacum officinale,* and *Bursa pastoris.*

DISCUSSION OF RESULTS

Some changes in vegetational cover occurred during the two seasons, apparently a result of moisture differences. In general, a rather close relationship existed between the total contribution by species to percentage of ground cover in the two seasons (1940 and 1941). If the single species, Kentucky bluegrass (*Poa pratensis*) is taken as an example it will be noted that relative percentages showed an increase in 1941 over 1940, excepting with seed mixtures No. 2. The principal differences were in the percentages of space having no vegetation.

Another interesting difference occurred between the total percentages (all soil treatments) of ground cover contributions by the native grass species during the two seasons. Some people have expressed the opinion that the use of fertilizers is effective in eliminating native species through stimulating competition by seeded grasses. Although the differences are not large (with one exception), soil treatment apparently is not a large factor in its effect on the presence or absence of native species.

Kentucky bluegrass seed makes up part of seed mixtures 1, 2, 4 and 5: however, it appears in most of the soil-treatment — seed-mixture plots, including plots of mixture No. 3 where no bluegrass was seeded. The lowest percentages of bluegrass are found on the series of plots which did not receive fertilizer. No bluegrass was found on the untreated plot of mixture No. 3 in 1941. Where phosphorus was part of the fertilizer application treatment, Kentucky bluegrass provided the larger part of the ground cover.

Orchard grass (*Dactylis glomerata*) occurred in appreciable percentages where seeded. Some small percentages occurred on a few plots of seed mixture series No. 5. It was assumed that some seed was carried in from mixture No. 4 by wind.

Timothy (*Phleum pratense*) was seeded in mixtures No. 3 and No. 5. Only small percentages are found in seed mixture series No. 3 plots, with a trace in one plot of seed mixture series No. 2. After some six or seven years, competition and mowing seems to have limited timothy to a few surviving plants.

Redtop (*Agrostis alba*) was seeded in seed mixture series Nos. 1, 3 and 4. After a few years, redtop cannot compete successfully with Kentucky bluegrass, particularly where soil treatments favor the former. On seed mixture series No. 3 plots, where bluegrass was not a part of the original seeding, redtop is well established.

A number of other interesting relationships are apparent in Tables 1 and 2. From a practical point of view, and over a period of years, it would seem to be more economical to omit alsike clover (*Trifolium hybridum*), white clover (*Trifolium repens*), redtop and timothy and certain seeds from mixtures containing bluegrass because they do not seem to constitute a large part of the ultimate turf. However, these species fill a very definite place in seeding mixtures. Redtop, timothy, and orchard grass act as nurse crops for the more slowly germinating Kentucky bluegrass and as "filler" grasses until such a time as the more aggressive Kentucky bluegrass begins to spread.

TABLE 2.—GROUND COVER PERCENTAGES OBTAINED ON NOVEMBER 18-19, 1940

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed mixture No. 1—consisting of Kentucky bluegrass, redtop, white clover and alsike clover									
Ky. bluegrass	80	49	49	55	48	36	39	54	52
Redtop			8	6	2	3	10	3	5
Orchard grass								1	
Native grasses					4	8	3	2	
White clover				1					
Alsike				1					
Lespedeza			2	3	4	11	5	1	
Weeds	2	3		1	4	5	3	1	1
No vegetation	11	28	29	23	31	29	34	20	24
Dead vegetation	7	20	12	10	7	8	6	18	18
Seed mixture No. 2—Kentucky bluegrass, Bermuda grass, white clover, Korean lespedeza									
Ky. bluegrass	93	83	81	71	63	35	68	63	62
Timothy							2		
Native grasses			2		2	6	1	1	2
Lespedeza				2	2	10	2	2	5
Weeds	1	2	2			6	1	10	5
No vegetation	1	3	7	15	20	36	18	13	22
Dead vegetation	5	12	6	12	13	7	8	11	4
Seed mixture No. 3—Timothy, redtop, red clover, Korean lespedeza									
Ky. bluegrass	5	16	7	12	30			29	8
Redtop	23	43	34	27	19	25	37	10	28
Timothy	1	1		3	6	5		10	9
Orchard grass	7						1		
Native grasses				2		6	6	2	2
Lespedeza			6	7	4	12	9	2	7
White clover				1					1
Weeds	19		9	3	1	2	5	8	6
No vegetation	27	25	15	21	29	41	32	27	33
Dead vegetation	18	15	29	24	11	9	10	12	6
Seed mixture No. 4—Kentucky bluegrass, redtop, orchard grass, lespedeza, white clover									
Ky. bluegrass	23	32	42	31	28	1	1	28	4
Redtop	1	3	8	6	4	11	8	9	7
Orchard grass	45	32	13	19	21	14	24	22	11
Native grass									1
Lespedeza				3		18	23		9
Weeds	5					6	2	1	13
No vegetation	18	29	29	35	34	31	40	33	47
Dead vegetation	8	4	8	6	12	19	2	7	8

TABLE 2—*Concluded*

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed mixture No. 5—Kentucky bluegrass, timothy, sweet clover and white clover									
Ky. bluegrass	37	48	55	51	55	30	43	52	48
Redtop							2		11
Orchard grass	10	14	4			4	4	8	7
Native grasses			2	2	2	6			
Lespedeza						2	9		
Sweet clover							1		2
Weeds	20	6	12	4	3	16	6		3
No vegetation	23	21	14	31	25	26	29	29	27
Dead vegetation	10	11	13	12	15	16	6	11	2

TABLE 3.—GROUND COVER PERCENTAGES ON AUGUST 14, 1941

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture No. 1									
Ky. bluegrass	74	65	45	38	43	31	51	57	55
Redtop				5	2	4	4	4	2
Native grasses			6	4	6	28	20	6	4
Lespedeza			13	14	6	13			
Weeds	3	2			8	5	1	6	4
No vegetation	13	18	23	27	29	19	21	22	28
Dead vegetation	10	15	13	12	6		3	5	7
Seed Mixture No. 2									
Ky. bluegrass	56	57	48	53	54	37	46	48	49
Native grasses	1		3		1	3	2	4	1
Lespedeza				4	1	7	7	1	
Weeds	5	5	1		1	4		10	
No vegetation	28	26	35	30	29	42	30	20	32
Dead vegetation	10	12	13	13	14	7	15	17	18

TABLE 3—*Concluded*

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture No. 3									
Ky. bluegrass	29	40	9	32	2	.....	14	44	5
Redtop	15	17	40	27	15	39	55	11	29
Timothy	8	12	9	5	1	5	3	4	....
Native grasses	.....	.....	1	....	9	4	1	2	1
Lespedeza	.....	.....	....	4	56	19	2	.....	8
Weeds	16	.....	6	2	1	4	....	7	17
No vegetation	28	24	29	21	15	21	24	25	35
Dead vegetation	4	7	6	9	1	8	1	7	5
Seed Mixture No. 4									
Ky. bluegrass	23	32	30	21	27	1	5	27	10
Redtop	.....	1	2	5	4	2	....	5	1
Orchard grass	30	28	24	21	18	11	19	26	10
Native grasses	.....	.....	....	3	1	2	....	2	....
Lespedeza	.....	.....	....	8	7	60	53	3	24
Weeds	3	5	1	3	4	4	3	.....	10
No vegetation	36	26	33	28	23	16	15	25	40
Dead vegetation	8	8	10	11	11	4	5	12	5
Seed Mixture No. 5									
Ky. bluegrass	65	52	60	65	62	22	29	56	49
Redtop	.....	.....	....	....	.....	3	1	2	2
Timothy	.....	1	....	....	.....	.....	1	.....	....
Orchard grass	3	16	1	....	.....	9	3	3	2
Native grasses	.....	.....	5	6	4	33	25	1	4
Lespedeza	.....	.....	....	....	.....	2	12	.....	2
Weeds	6	11	3	3	5	6	4	1	3
No vegetation	22	13	23	20	18	22	22	29	31
Dead vegetation	4	7	8	6	11	3	3	8	7

The value of soil treatments can be assessed by comparing vegetational percentage totals and yields for the two seasons. These comparisons are shown in Tables 1 and 4.

No correlation between yields and percentages of ground cover is apparent. The relatively low yields of forage obtained from the "no treatment" plots trend toward correlation with the ground cover percentages as shown in Table 2. The high forage yields obtained from the nitrate-rock phosphate treatment are not reflected in the ground cover percentages. Weed species and orchard grass contributed materially to the forage yields on treatment plots 1, 5, 7, 8, and 9 of seed mixture No. 4.

Total yields of forage from all mixtures with the same treatment

TABLE 4.—VEGETATIONAL COVER PERCENTAGES AS AFFECTED BY SOIL TREATMENTS

Nov. 1940	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture									
No. 1	82	51	59	67	62	63	60	62	58
No. 2	94	83	85	73	66	57	74	76	74
No. 3	55	60	56	55	60	50	58	61	62
No. 4	74	67	63	59	54	50	58	60	45
No. 5	67	68	73	57	60	58	65	60	71
Totals	372	329	336	311	302	278	315	319	310
Average	74.4	64.8	67.2	62.2	60.4	55.6	63.0	63.8	62.0
August 1941									....
No. 1	77	67	64	61	65	[1]81	[1]76	73	65
No. 2	62	62	52	57	57	51	55	63	60
No. 3	[3]68	69	65	70	84	[2]71	[2]75	68	[3]60
No. 4	56	66	57	61	66	[2]80	[2]80	63	55
No. 5	74	[3]80	69	74	71	[1]75	[1]75	63	62
Totals	337	344	307	323	343	358	361	330	302
Average	67.4	68.8	61.4	64.6	68.6	71.6	72.2	66.0	60.4

(1) Includes large percentage of native grasses. (2) Includes large percentages of annual Korean lespedeza. (3) More than 10 per cent weed species.

are shown in Table 5. These data give conclusive evidence of the effect of these treatments on yields.

SUMMARY AND CONCLUSIONS

The effect of soil treatment on yields of air-dry hay indicate that nitrogen, phosphorus, potash and lime give large increases. Percentages of ground cover contributed by the various species are not related directly to yields when the point quadrat method is used. Some trends can be noted, but they are not consistent from year to year. Prevailing moisture conditions in a given season and the distribution of that moisture affect the percentage composition of the ground cover as well as the yields. Kentucky bluegrass (*Poa pratensis*) and orchard grass (*Dactylis glomerata*) and redtop (*Agrostis alba*) were most consistent in contributions to the percentage ground cover. The former species is aggressive and persistent on treated soils.

Some species, after a period of years, have been almost completely eliminated from the plots. Legumes, excepting Korean lespedeza (*Lespedeza stipulacea*) made up a very small part of the vegetation.

Botanical analyses using the point quadrat are valuable in measuring ground cover, but should not be re-

TABLE 5.—TOTAL YIELDS OF FORAGE FROM SOIL TREATMENT SERIES FOR 1940 AND 1941

Mixture	Soil Treatments								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
	Yields in Pounds Per Acre								
No. 1	2208	2408	2090	2413	2558	1854	1867	2293	2088
No. 2	5658	3700	1353	1554	1844	918	976	4318	1803
No. 3	8202	7555	2052	3502	3510	1541	3256	6202	5158
No. 4	7561	2137	1790	1961	3340	1502	8765	4838	4852
No. 5	7519	8216	8333	8254	6571	2912	4042	7953	4636
Total yields	31148	24016	15618	17684	17823	8727	18906	25604	18537
All mixtures with same treatment									

lied on as a measure of component weight contributions of the different species. Where a single specie is dominant or makes up a large percentage of the vegetation on a given plot the forage yield and point quadrat percentages are usually directly related. The inclusion of a single clump of vegetation such as orchard grass in a small yield sample can seriously disrupt this relationship, when the yield is calculated on an acre basis.

1. LEVY, B. E. AND MADDEN, E. A. The Point Quadrat Method of Pasture Analysis: New Zealand Jour. Agr., 46: 1933.

2. ARNY, A. C. AND SCHMID, A. R. A Study of the Inclined Point Quadrat Method of Botanical Analysis of Pasture Mixtures: Jour. Am. Soc. Agronomy, 34: 1942.

POPULATION CHANGES IN RURAL LIFE

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The farm areas in the United States lost 16.8 percent of their population from 1940 to 1945. The major movement was due to wartime expansion in non-agricultural employment. This drain of population from rural areas reduced the number of people living on farms to slightly over 25 million, the smallest number of farm residents in the last 35 years, the period for which farm population estimates are available.[2]

All counties in Illinois, except ten which were located in or near war industries or military camps, lost in population from 1940 to 1943. More than a fourth of the counties, on the other hand, lost 15 percent or more of their population in this period; most of these were rural counties in poor-land areas not containing any form of wartime industry. The highest decreases were for Pope, Johnson, Pulaski, Alexander, Gallatin, Fayette, Scott, and Brown Counties, each of which lost 20 percent or more in population from 1940 to 1943.[3]

The number of farms decreased, moreover, in three-fourths of the counties from 1940 to 1945. Five of the six counties having had an increase of 100 or more farms in this period also had increases in population;[4] four counties, on the other hand, in which there was a decrease of 15 percent or more in the population had decreases of from 10 to 87 farms per county from 1940 to 1945.[5] Perry County with a decrease in population had a decrease of 308 in number of farms in these war years. The general trend over the state, therefore, was toward decrease in numbers and increase in size of farms. This trend may be expected to continue unless employment sluffs off in the urban areas and people begin to return to the farms again as they did in the last depression period.

Current reports made during the last four months of 1945 on a national sample of 71 counties indicated that a substantial return of migration to farms started in many parts of the country after Japan was defeated. "The most important and most widespread change in farm population which took place after the end of the war was the return of demobilized veterans."[6] A fourth to a half of those who had entered the armed forces had returned home by Christmas. Some in war industries were returning; and many non-farm jobs to which farmers had been commuting were cut off.

Return migration to farms was light in counties of the Wheat Belt and Range-Livestock Regions, and also in Dairy Belt counties. There was heavy return of wartime migrants to the poorer, self-sufficing counties of the Southern Appalachians. In the Corn Belt no serious reemployment problems of persons returning to farms had yet developed by the first of the year 1946. In the Dairy Belt there was considerable shifting from one non-farm job to another by residents after the war ended, but no serious problems of unemployment. There was still a shortage of labor on dairy farms.

[1] Professor of Rural Sociology.
[2] "Farm Population Estimates," BAE, USDA, July 1945.
[3] "Illinois Resources," Illinois Postwar Planning Commission, Chicago, Nov. 44, p. 157.
[4] Lake, DuPage, Kankakee, Champaign, and Rock Island.
[5] Pulaski, Saline, Scott and Henderson.
[6] "Farm Population Adjustments Following the End of the War." Summarized by Margaret Jarman Hagood, BAE, USDA, Feb. 1946.

The general trend over a long period of years has been for a net migration from rural to urban areas. Although the migration that developed during the depression decade of the 1930's was altered by the war, what happened then and in the 1920's can be a guide in planning for the next ten or twenty years. During the decade of the 1920's—a period of general urban prosperity—net movement of population away from farms was about 630,000 per year. In the 30's when depression time came, the average for the first five years was only 195,000 net movement per year; in 1932 there was a net migration to farms of 325,000. During the last half of the decade net migration from farms increased to about 550,000 per year. Then there was a rapid increase in the rate of migration for 1941, 1942, and 1943; but by 1944 the rate again began to decrease and continued to decrease in 1945.

In spite of the net migration away from farms, the farm population in 1940 was about the same as in 1930, 30,269,000, but in 1945 the farm population had dropped to 25,190,000. A larger than proportionate amount of this wartime loss was from farms of the South, where great underemployment of farm workers existed before the war—areas that needed to lose people. Nevertheless, in 1945 the South had 52 percent of the total farm population with a much smaller proportion of the nation's agricultural production or productive resources other than labor. The same situation is reflected in the State of Illinois. The poor-land areas, where farms are relatively small, contributed larger numbers, proportionately, to the out-farm migration; yet, these areas still have a relatively large proportion of the rural-farm population of the state with a much smaller proportion of the state's agricultural production or productive resources other than labor.

The fastest growing population in America has been the rural non-farm population—the people not engaged in farming who live in small towns and villages and in the open country. Most of the increases in this element of the population has been near cities and industrial centers; people have moved out along the highways, railroad and bus lines so as to be able to go back and forth to their jobs in the cities. There has been somewhat of a trend for small industries to move into the smaller communities. The result has been a movement of people not only from the crowded cities to live in the less congested smaller places, but also for those not wishing to continue to farm to move into or near these centers.

The only two elements in the total population which over a period of years have reproduced themselves have been the rural-farm and the rural-non-farm populations. It is anticipated that the rural-farm population will not only continue to produce more children than can profitably remain on farms, but also that the pressure will be accelerated by the trend toward fewer and larger farms. It may be, also, that the movement from cities to rural-non-farm areas will continue, especially if the movement toward placing small industries in rural communities continues. There should be increased concern — more planning done—it would seem, to provide increased employment opportunities and better school, health, library, recreation, and social welfare services for the smaller communities of the state and nation in view of the fact that they are evidentally destined to become an important residence and resource of our population.

EFFECT OF MINERAL NITROGEN ON THE YIELD AND PROTEIN CONTENT OF FARM CROPS

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The production of mineral nitrogen has been greatly increased in recent years. A large part of this production may now be diverted to fertilizer use, which may make available a larger supply of commercial nitrogen for application on land devoted to general farm crops. There has been a tendency for the selling price of this material to decline. It is the cost and possibility of profit which will be the controlling factor in its use in general farm practice.

Nitrogen fertilizers may have two separate and distinct effects on crops. First, the crop may respond with an increased yield and second, there may be a considerable increased protein content of the crop. Under favorable conditions mineral nitrogen has been found to increase the yield and to some extent, the protein content of grain crops. When applied to hay and pasture grasses, its use is usually accompanied by a large volume of growth and a considerable gain in protein content of the grass.

The effective use of mineral nitrogen in crop production, broadly speaking, depends upon seasonal conditions, soil conditions, and the amounts and manner in which the nitrogen is used.

Soil conditions likely to give large crop response are those lands which have been largely depleted of the natural supply of organic matter and therefore have a low nitrogen-supplying power. Farms which have rather consistently had regular rotation of crops, including liberal additions of legume material to the soil, have been found less responsive to nitrogen fertilizers than soils not adjusted to this advantage.

It is essential to have a proper balance of fertility elements in soils if best results are to be obtained from the use of mineral nitrogen. The effect of this balance may be observed in results from the Enfield and Elizabethtown fields (Table 2). Nitrogen in the form of ammonium sulphate was added to redtop and bluegrass, and increases amounting to 3,000 pounds and 1,650 pounds of hay were obtained on the respective fields. When the same amounts of ammonium sulphate were balanced with applications of superphosphate, the gains in hay yields amounted to 4,770 pounds and 4,150 pounds respectively on the two experiment fields. The lack of balance was also apparent on the Garvis farm (Table 1), where phosphorus and potassium fertilizers gave a 2,350-pound increase in corn yield over the untreated land. When this fertilizer (0-20-20) was balanced with 100 pounds of nitrogen in the form of sodium nitrate, there was an increase in corn yield amounting to 4,250 pounds an acre.

Nitrogen makes up the largest quantity of the several fertility elements taken up by the corn crop. The average amount is 140 pounds of nitrogen in the grain, stalks, and cobs for each 100 bushels of grain under Illinois conditions. Potassium is the second highest of these elements with an average of 112 pounds in the entire growth which goes with 100 bushels of grain. Phosphorus is relatively low with an average of 18 pounds in the grain,

stalks, and cobs. Nearly two-thirds of the nitrogen, 102 pounds, was in the grain. More than twice the amount of potassium, 76 pounds, was in the stalk and cobs as compared to that in the grain, 36 pounds. There was approximately three times as much phosphorus in the grain, 13.4 pounds, as that in the stalks and cobs, 4.4 pounds.

Mineral nitrogen in the form of sodium nitrate applied in addition to phosphorus and potassium (0-20-20) on the Garvis farm (Table 1) gave an increase in total crop of 1,900 pounds an acre. There was a rather significant gain of 14 bushels of grain from this nitrogen treatment. This grain contained 11.0 percent protein compared to 10.5 percent protein in the corn without the nitrogen treatment. This small difference in total protein might be of little significance in the feeding value of the grain, and would therefore add little value to the crop.

The loss of available nitrogen has a depressing effect on corn yield as illustrated by results from the Young farm (Table 1). In this test, 2½ tons of oat straw was spread on the land in November and plowed into the soil the following spring. This application of straw apparently rendered unavailable approximately half of the nitrogen in the soil and, consequently, reduced the total dry matter in the corn crop by 3,550 pounds, or 32 percent. The total nitrogen in the crop was reduced 50 percent, phosphorus was reduced 62 percent, and the amount of potassium by 34 percent. There was a 14-bushel decrease in the grain yield, which contained 29 percent less protein because of the shortage of available nitrogen.

The untreated (none) land on the Young farm (Table 1) was relatively high in available nitrogen because it had been under a system of fallow cultivation through the 1941 season in order to destroy thistles.

The addition of nitrogen fertilizers to various grasses usually results in larger yields and higher protein content. The benefits are usually in proportion to the amount of nitrogen applied, up to a certain limit. At Enfield, where 100 pounds of ammonium sulphate were applied to a redtop sod in April, a hay yield increase of 770 pounds with a protein content of 6.5 percent was obtained. Where 500 pounds an acre of ammonium sulphate were added, the hay yield gained 4,370 pounds and contained 9.4 percent protein. Thus the larger amount of nitrogen produced more hay which had a relatively higher feeding value based on protein content.

The redtop hay yield was increased 3,000 pounds by the addition of 400 pounds of ammonium sulphate, and the protein content was increased 80 pounds a ton over that on untreated (none) land (Table 2). Where 500 pounds of superphosphate were added along with the ammonium sulphate, there was an additional increase of 1,770 pounds of hay but no additional increase in protein. The 1945 season was unusually favorable for the growth of redtop, which may in part account for the large hay yields.

The eroded hill land, on which the Elizabethtown field is located, is very deficient in available nitrogen and phosphorus, and will not grow bluegrass satisfactorily without the addition of these elements in an available form. This soil condition accounts for the rather unusual increase from 250 pounds up to 4,400 pounds of hay an acre where nitrogen and phosphorus (NP) were added to the soil (Table 2). The rather large increase in protein content of the bluegrass, 150 pounds up to 310 pounds at Elizabethtown and

180 pounds up to 308 pounds at Joliet, was due in part to the physiological change in the growth of the grass brought about by the fertilizer treatment. Kentucky bluegrass at the full head stage of growth is usually a stemmy hay, but the nitrogen fertilizer caused the growth to become almost entirely of a leafy nature. This change in growth habit accounts in part for the relatively large gain in total protein in the grass on fertilized land.

The untreated (none) soil on the Joliet field grew satisfactory bluegrass without additional treatment as indicated by the 1,560 pounds as the acre yield. The relatively lower hay yields on the fertilized land of the Joliet field were due in part to seasonal conditions and management difficulties. This fertilized land produced a heavy growth which persisted late in the fall and caused smothering out of the growth, with consequent reduction in yield the following spring.

TABLE 1.—COMPOSITION AND YIELD OF CORN AS AFFECTED BY VARIOUS SOIL TREATMENT ON TWO FARMS. 1942

Soil Treatment	Entire Crop, lbs. an Acre				Grain			
	DM	N	P	K	bu.	Protein %	P %	K %
Garvis Farm								
None.....	7170	94	7	83	73	10.0	.14	.59
PK.....	9520	115	11	96	82	10.5	.20	.50
NPK.....	11420	151	15	130	96	11.0	21	.55
Young Farm								
None.....	11110	151	16	174	77	11.4	.24	.68
Straw....	7560	75	6	115	63	8.1	.11	.72

DM—stalks, grains, cobs.
PK—500 lbs. 0-20-20 fertilizer.
N—625 lbs. $NaNO_3$
Straw—2½ tons oat straw.

TABLE 2.—YIELD AND COMPOSITION OF REDTOP AND KENTUCKY BLUEGRASS HAY AS AFFECTED BY NITROGEN AND PHOSPHATE FERTILIZERS ON THREE FIELDS, 1945

Soil Treatment	Enfield		Elizabethtown		Joliet	
	Hay lbs./A	Protein lbs./ton	Hay lbs./A	Protein lbs./ton	Hay lbs./A	Protein lbs./ton
	Red Top		Bluegrass		Bluegrass	
None.....	3290	132	250	150	1560	180
N.....	6290	212	1850	310	2540	308
NP.....	8060	200	4400	305	2330	300

N—ammonium surphate
Enfield 400 lbs. an acre each year total 800 lbs.
E-town 500 lbs. an acre each year total 2500 lbs.
Joliet 500 lbs. an acre each year total 2500 lbs.

P—20% superphosphate
Enfield total 500 lbs.
E-town total 500 lbs.
Joliet total 750 lbs.

ANTHROPOLOGY

CORD-DECORATED POTTERY IN THE GENERAL PEORIA REGION

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Cord-decorated* pottery, a pottery decorated with cord-imprint lines, is a quite distinctive type of Woodland pottery occurring at various sites in Illinois but not often described or commonly familiar. It is here reported as known to the writer from a number of sites in the middle Illinois River Valley, in the general region of Peoria, with special attention given to the Clear Lake Village representation.

The outstanding trait of this ware is a surface decoration utilizing a short straight cord-imprint as a line, the line being employed to form geometrical and linear arrangements on neck and lip, or lip only. A "squared mouth" effect, produced in several ways, is a second conspicuous characteristic. There are, also, other distinctive features.

The cord-impressed decoration is stated by Dr. James B. Griffin, Assistant Curator, Ceramic Repository for the Eastern United States, University of Michigan, to be very widespread in North America east of the Rockies, and its ultimate origin he believes to be Asiatic. A cord-decorated pottery of Illinois, designated as Maples Mills Cord Decorated, is considered one of the late boundaries of the Woodland in Central Illinois. Mr. Griffin states that this ware has never been earlier than, or contemporary with, Hopewellian but always later, and that it has never been found outside of a local area. Its presence on a Hopewellian, or other culture, site indicates successive periods of occupancy of the site.

A cord-decorated ware in Wisconsin was described by Dr. S. A. Barrett in *Ancient Aztalan*, 1933 publication of the Public Museum, Milwaukee, Wis. An angular mouthed ware was designated simply by the general term, "Woodland ware;" a circular mouthed was called Lake Michigan ware. Both have been stated to belong to the Michigan phase of the Woodland, a phase named by Dr. W. C. McKern of the Milwaukee Public Museum.

Cord-decorated pottery from central Illinois was described by Dr. Fay-Cooper Cole and Dr. Thorne Deuel in *Rediscovering Illinois*, 1937 publication of the University of Chicago, dealing with exploration in Fulton County, and was designated as "Type 5, Maples Mills Corded-Design." It was stated to occur at the Gooden component in Fulton county and also at the Clear Lake Village and Mound sites in Tazewell and Mason counties. The Gooden component was classified as belonging to the Maples Mills focus, undetermined aspect, phase tentatively designated Tampico, Woodland pattern. The name, "Gooden Cord Impressed", has been used for this ware by Dr. Griffin, who considers it to be a recognizable subdivision of the pottery belonging to the Lake

* Cord decorating should not be confused with cord roughening, which is an all-over rough surfacing such as could result from use of a cord-wrapped paddle in shaping the pot.

Michigan phase of the Woodland. Amounts of the ware were given as three ollas and a few sherds at the Gooden site, and nine sherds, including rims, at the Clear Lake sites.

Cord-decorated ware was reported from the Clear Lake, Mossville, and Blumenshine or Knocke Villages by the writer in 1940 and was further described in Clear Lake reports of 1941, 1942, 1943 and 1944, published in *Transactions* of Illinois State Academy of Science.

Two appearances of pottery with cord-impressed decoration were described by Mr. Griffin in *Contributions to the Archaeology of the Illinois River Valley*, 1941 publication of the American Philosophical Society, dealing with explorations along the lower Illinois River valley made by Dr. Warren K. Moorehead for the University of Illinois. The ware was recorded from the Hagan Mounds at Browning, Illinois, and from Snicarte Village, near Snicarte, Illinois; the Hagan pottery was stated to closely resemble that belonging to the Maples Mills focus, and a majority of the Snicarte ware was said to be of the Maples Mills type. Mention was made that similar pottery had been collected by Mr. J. L. B. Taylor at a number of village sites in Illinois River valley.

The Corbin site in northern Illinois is listed as of the Maples Mills focus, with the University of Illinois as the source of record.

This 1946 report concerns cord-decorated pottery from nineteen sites, some but not all recorded in the Peoria Academy of Science archaeological survey. Included are Clear Lake village (No. 30), Blumenshine or Knocke village (No. 5), Steuben village (No. 22), Rench village (No. 3), Williams village (No. 24), Copperas Creek village (No. 32), Partridge Creek Village (No. 33), Mossville village (No. 10), Hildemaier village (No. 4), Krause site, Ashelon village (No. 35), Metamora Road site, Little Creek site (No. 39), Crane site, Keithburg site, Platform Hill site, Texaco site, Schultz village (No. 36), Orchard Mines village (No. 37).

Material studied, in addition to the Schoenbecks', is from the collections of Anson M. Simpson (now the property of Peoria Academy of Science), Virginius H. Chase, Leroy P. Elliott, and Willis D. Speight.

Maples Mills cord-decorated ware has been shown, through excavations made at Clear Lake Village by Mr. and Mrs. Schoenbeck and Mr. Simpson, members of Peoria Academy of Science, to have been present there in considerable amount, and to have forms, characteristics, and variations additional to those recorded in Cole and Deuel's original type description. The Schoenbeck collection now includes about 120 rims, over 200 lower rims, considerable portions of nine pots, one decorated body sherd, and some hundreds of cord-roughened body sherds, recognizable when they bear a particular cord roughening characteristic of a part of the ware. The Clear Lake representation seems, to-date, to have strong individuality but also includes variations.

This ware, in such an amount, at this site classified as Hopewellian, shows successive occupation of the site by early and late peoples. Clear Lake Village has now been shown to have had a long occupation and a long pottery developmental sequence with changing concepts. Extended research, resulting in richer discovery, has borne out Cole and Deuel's original hypothesis. The pottery sequence has recently been pronounced by Dr. Deuel to be the longest known for any site in Illinois. The exceptionally rich pottery complex shows Woodland and Hopewell-

Photograph by William Holling.

FIG. 1.—Maples Mills cord-decorated ware:

Clear Lake Village, Nos. 1 to 7.
First row—1. alternate diagonal-hachured triangle.
2. alternate hachured and plain triangle, double row.
3. horizontal lines, broken by line and punctate design at point area.
Second row—4. diamond pattern.
5. angular, but ungeometrical design.
6. body sherd showing fat, 2-ply-cord cord-roughening.
7. Corded Lip, plain surfaced.
Third row—8. Knocke Village, Corded Lip, 2-ply-cord cord-roughening.
9. Orchard Mines Village, Corded Lip, plain surfaced.
10. Orchard Mines Village, Corded Lip, plain surfaced.
11. Schultz Village, whole rim decorated, lugged.
Specimens 9, 10, and 11 are from the Willis D. Speight collection.

ian in early, transitional, advanced and latest forms. It includes all Woodland and Hopewellian types listed by Cole and Deuel for Fulton County and Clear Lake; most of those described by Griffin for the lower Illinois River valley; some not yet described or named as types, including ware not previously known to Dr. Griffin; Marksville Red Filmed, Negative Painted, Thickened Rim, Gono Cord, Morton Incised and additional types. Several Mississippian types are present in exceedingly small amount. Maples Mills ware would be the latest Woodland type.

To the original Maples Mills descriptive data, the writer has added, from occurrences revealed in the

Clear Lake representation, the use of two particular temperings; the frequent appearance of a special cord roughening; other punctates, surfaces, designs, necks, colors and shapes; more descriptive details for the various features; and a few variations differing in one or more chief characteristics. Variations are described separately. A sub-group is suggested for one; a type for another.

Decoration, emphasizing and encircling the neck, expresses the idea of collaring. Confined to necks, lips and neck lugs, with one exception, it consists of both surface ornamentation and modeled features. Surface decorative elements are the cord-imprint and the punctate. Modeled features number three, all used to produce the "squared mouth" effect, the raised point, the lug sometimes placed on the point, and the trimmed or "cut-out" lip. A modeled collar is reported under the suggested type. Flaring the points, also sometimes angling or cornering them, often aids in accomplishing the "squared mouth," which seems limited sometimes to an effect only, the base of the neck remaining circular. In the cord-decorated, lugs are used only as additions to points, to strengthen the effect, never accomplishing effect alone. Decoration of lip is a strong characteristic.

Decoration always covers the entire neck on the exterior; it often appears on the interior in the area bordering lip, and in rare instances, extends the neck depth. It appears on practically all lips and on all lugs. It is often finished at top and bottom with enclosing or bordering lines, strengthening a horizontal or band effect around the neck, and is placed on both cord-roughened and smoothed surfaces.

Cord lines are used to form geometrical designs and patterns for the band. Designs composed of lines in other angular arrangements do occur, but rarely. Design units are commonly repeated to build up the pattern for the band and are modified in shape and arrangement to conform with the widening of the band where the raised points occur. Special arrangements of lines often mark the point areas. The triangle is the common design; a ladder, a very rare one. Designs and patterns other than the geometrical are not identified yet, or easily described. The row of alternating triangles; the group of horizontal lines, broken at the point areas; and the diamond comprise the identified patterns. Triangles alternate in surfacing, hachured and unlined or hachured in opposing directions, such as the two diagonals. The unlined triangle may be smooth or cord-roughened. Occasionally two rows of triangles, one above the other, occur. The pattern of horizontal lines is broken at points with a design or an arrangement of lines. The diamond pattern is a simple crossing of oblique lines.

A comparison with the Aztalan ware shows that whereas the line arrangements in that ware were reported so varied that each new sherd was expected to be different, much of the ware of the Peoria region lacks variation, having considerable repetition.

The cord line is one half to several inches long. Cord is 2-ply twisted, and is generally large and round but varies to quite fine. It appears singly, in pairs, and in groups. In the paired imprints, the ply twists of the two cords may appear in the same or opposed positions. A long, continuous, horizontal line may not only border the band or make up the pattern but also parallel the lip on

the interior or run through the lip surface entirely around the circumference. Fine striations often show in imprints, suggesting a rather harsh fiber. A cord differing in some respects from the usual also occurs. As to methods of producing the cord imprint, a paddle with neatly spaced cord wrapping could have produced all short lines, including groups. Long straight lines might have been made by the short line repeated, end to end; long curved lines might require a length of cord. A short touch with paddle edge could make the punctate.

The punchmark, or punctate, appears on both outer and inner rim surfaces, on both outer and inner edges of lip, and on top lip. Used on lip it sometimes produces a notching effect which might be called punch-notched; when this notching is closely spaced a waving edge results, which might be called punch-waved. It has been repeated to form a bordering line for the band, the line generally subtending when used at base. Rarely it may form lines in design.

It includes the common punctate; the cord punctate (Cord Punctate being a name previously offered by the writer as more correct than "Bent Twig"); a fingernail punctate, and a flat punctate. The fingernail is a small, sharp, curved line (such marks often occur on inner surfaces of pottery where made accidentally in the manufacture of the ware). The flat is a broad imprint such as might be made with the back of a thumbnail or by a bare paddle edge, lightly applied.

The principal shape has a vertical neck, sharply set off from the much larger, somewhat flattened shoulders of a globular body or of a bulging-shouldered body with semiconoidal base. A globular form without the shoulder flattening also occurs. A different neck is one that is curved and flaring.

Another flattened-shoulder globular body with a differing rim, a sloping-shouldered jar, a form with brief rolling rim, and other variations are among those described separately. Necks generally measure two to three inches, though shorter ones occur. Though the neck is sometimes straight, it often flares slightly at top or bottom, or both. Size of pots ranges from small to quite large. Mouth diameters vary from 4¾″ to 14″ and a large pot may be 53″ around.

Lips may not only be simple and rounded; or horizontal, often flanged and overhanging exteriorly; but also outwardly sloped, both with and without the overhang; briefly rolled; horizontal and flat; and sometimes considerably thinned and waved. Overhanging lips may measure ½″ in width. Lips are mostly decorated, some elaborately, lip decoration being a conspicuous feature.

The raised points, produced by a gradual heightening and lowering of the rim top edge at intervals around the mouth, seem to number four as indicated by spacing and shaping on rim portions of sufficient size to show. The lugs, sometimes present on rim at tips of raised points, are elongated, vertically placed, and always decorated.

While the usual color is a red-brown, there is also a gray-tan and an infrequent gray-blue. Inner surfaces, well smoothed, are often decidedly blackish, and the writer suggests they may have been subjected to some slight treatment. To the cord-roughened exterior originally cited is added a smooth one, an infrequent occurrence described among the variations.

The distinctive surface-roughening, reported as a characteristic of a portion of the Clear Lake ware in

1944, definitely identifies even an undecorated body sherd, making it easily recognizable at a glance. The general effect is an all-over pattern showing orderly alternating small oval pitting or dimpling, such as might be caused by the bulging twists of fat-bodied strands in a 2-ply cord. Sometimes noticable are broad corrugations in an up and down direction, caused perhaps by quite round full cords. The strand imprints often show the fine striations noticed in the decorative cord line imprints. The whole appearance is dull in texture and surface finish, showing no polish or highlight.

The previously reported, particular, black, sharp-angled tempering material, or basaltic hornblende, suggested by the writer as possibly the same tempering described for part of the Aztalan ware, is coarser than the other grit used, and in the coarsest sherds is sometimes exposed on the surfaces as flat, black planes with irregular outlines. Clay has a tendency to crack or flake. Other grit used may be quite fine, allowing hard surfaces and thin walls. A tempering material containing lime was used also, as indicated by leaching out of tempering fragments, leaving holes. A pottery with missing tempering is also described from Aztalan, as "cell-tempered" pottery in which the tempering has disappeared, leaving empty cells.

Walls vary from quite thin to heavy, the thinnest being about 2 millimeters or 1/12 inch and the thickest, about 1 centimeter or 2/5 inch. They often thicken at the joining neck and shoulder.

Variations include the following specimens. There is a sloping-shouldered jar shape with alternating hatchured triangle decoration applied crudely over cord-roughening which shows the fat-bodied cord. Lip slopes outward and bears the cord running through center and cord punctates on outer edge.

Three variations are plain surfaced. One has a one-inch vertical neck, undecorated but for the cord line running through the center of the flat, horizontal lip. It is yellow-brown in color and has the black angled tempering. Ware with only the lip decorated appears also at other sites, with frequency and in amount sufficient to give it identity, and the writer suggests it might be considered a subgroup of Maples Mills Cord-Decorated and designated as Maples Mills Cord-Decorated Lip pottery. Maples Mills "Corded Lip" might suffice. Although necks are generally plain and smooth, one specimen from another site shows fat-cord cord roughening on the body.

Another plain surfaced sherd has no neck, only a brief rolled rim with wide flat horizontal lip that overhangs exteriorly, bearing short cord lines across its surface. It is dark gray in color and the body seems to be globular. The interior is smooth; thickness is 3/16 inch. It might be considered as belonging to the "Corded Lip".

The third plain surfaced sherd is a lower rim showing only vertical cord lines. It is 5/16 inch thick and light brown.

Another variation is a shoulder sherd showing the strong shoulder, the black angled tempering, and the fat-cord cord roughening, but having a decoration composed of a round punctate and a fingernail punctate used together on the shoulder. This is the only decorated body sherd.

A collared rim ware, without cord decoration but apparently closely associated with, and possibly related to, the cord-decorated pottery, is present at this site. The rim is upright with the upper inch or half

inch thickened exteriorly, forming a collar. This collared rim is described for the Aztalan site, and Mr. Griffin states it is a feature of the pottery in the Lake Michigan phase in Wisconsin and Michigan and is often associated with Gooden Cord Impressed (Maples Mills Corded Design) pottery from northern Illinois. The writer suggests it be classed as a type and offers the name, "Maples Mills Collared," as correctly expressive of both its relationship and physical characteristics.

One collared specimen shows a flattened-shoulder globular bowl having a vertical neck, sharply angled with, and much smaller than, the shoulders. Lip is smooth, flat, horizontal, and thinner than wall which is ¼ inch thick. Exterior is cord roughened to lip with the fat-cord cord roughening and the interior is smooth. Color is dark red brown. Surface of collar slopes outward, forming a slight ridge at bottom. Tempering includes some black angled mixed with fine grit. Bowl is about 10 inches high and mouth is 11 inches in diameter.

Another collared rim shows a limestone tempering in process of disintegration, there being flinty fragments, crumbling fragments of limestone, and holes where other fragments have disappeared. Another has a one-inch collar.

Among other local sites showing cord-decorated ware, Blumenshine or Knocke village is important for having the type as its dominant one. It is not a large site and the material, mostly collected from the surface, is small in amount, but the purity of the pottery complex gives it special interest. There is almost a total absence of other Woodland ware. Of the 59 rims and lower rims in the Schoenbeck collection, 57 are cord-decorated, one is plain and one is Mississippian. Nearly all

FIG. 2.—Maples Mills collared ware: Clear Lake Village
Flattened shoulder pot has the fat 2-ply-cord cord-roughening.

body sherds are fat-cord cord roughened, or plain. Black angled tempering is much used but in combination with other. Most sherds show black interior surface. Designs and patterns are the usual ones, including the diamond, but several rims show decorations on lip or inner lip only. One hollow lug suggests it had been made by an outward push from the interior. One perforated lug is in the Simpson collection.

The Steuben site has an exceedingly small amount of cord-decorated pieces among hundreds of punctate, dentate stamped, and some finer Hopewell. Only nine sherds, two lower rims and seven body, are in the writer's collection. Eight have the fat-cord cord roughening and three have black interiors.

The Rench village has very small representation, although there is considerable dentate stamp and other Hopewell. Decoration in limited amount, on lip and inner lip, is noticeable, and so is the black inter-

ior. There is some fat-cord cord roughening and a little black angled tempering.

The Williams village has also but a small showing, with much more dentate stamped and Mississippian. The sherds, both from the surface and from excavations, show all to have the fat-cord cord roughening and most to have the black interior. There is some black tempering mixed with other.

The Partridge Creek village has yielded mostly cord-decorated pottery through surface collecting. The greater part has the fat-cord cord roughening, the black interior, and the black angled tempering mixed with other.

Copperas Creek site has a small showing of the ware from its plowed surface. The sherds are rather coarse and have mostly ordinary grit temper. There is little of the particular cord roughening and no black interiors.

The Mossville village ware is described as known from the Simpson collection. Two pots have cord decoration, the one across the lip and one on inner lip. The second has a pentagonal mouth. Cord is stated to be 2-ply. The diamond pattern is included among the few rims. A part of the ware resembles a heavy, rather coarse gray Woodland Plain or Woodland Cord roughened. The site has also Hopewellian and Mississipian wares.

Sites with the cord-decorated pottery, as revealed by the L. P. Elliott collection, included four already listed and in addition the Platform Hill site near Havana. This site showed pottery with the black angled tempering, one-fourth of which had the particular cord roughening. The representation was small.

Five additional sites are recorded from the Willis D. Speight collections. The Hildenmaier village, a Mississippian site with mounds, showed only one lower rim of a decided blue-gray color, gritty texture, and bearing cord lines.

The Texaco site had but one low rim, showing a lug without raised point, and the diamond pattern.

Pottery from the Ashelon, Schultz, and Orchard Mines villages was of one general character. It was decorated on lip only; was plain surfaced so far as rim shoulders showed; had outward-sloped, often wide lips, sometimes overhanging; was light reddish brown in color, rather coarse, gritty, and medium to heavy in thickness. Necks were vertical, sometimes flared at top, and were placed at an angle with the round full shoulders. There were some cord-roughened body sherds, a few showing the fat-cord roughening. There was little black angled tempering. One rim showed sloping shoulders and cord roughened body. Poor firing was indicated frequently by walls being gray in center. The greatest lip width observed was 9/16 inch.

Lip decoration consisted of one or several long cord lines running through center of lip, occasionally accompanied by punctates on outer edge of lip, and of short lines crossing the lip. Sometimes the long lengthwise line and the short crosswise line were used together. The short crossing line was sometimes oblique. Punctates included the tube (which shows a little peak of clay in center such as would be left by a hollow or tube-like tool) and the short incised. Only one rim and two lower rims had decoration similar to the usual Maples Mills. The rim had the raised point bearing a lug and the decoration the full depth of rim, composed of opposing lines. The lower rims had cord-roughened body attached; one showed a horizontal line and the other, punctates.

Ware from these sites might be included with that for which the name Corded Lip, was offered, considered as possibly a subgroup of Maples Mills Cord Decorated.

Material from the Krause site, the Metamora Road site, the Little Creek site and two sites not local, the Crane site near Crane, Ill. and the Keithsburg site near Keithsburg, Ill., contained cord-decorated ware as shown in the Virginius Chase collection. The local sites had merely a representation of the type, too small to furnish information other than a record of the ware, and revealing no different or outstanding features.

Of the two distant sites, the Crane site was of most interest. Its representation consisted of only one rim but it was entirely different. It had a wide plain band around the top of the rim, beneath which were vertical columns of short horizontal cord lines, the columns being repeated around the neck. The lip was horizontal, flat, and notched on inner edge. Tempering was ordinary grit. The rim was nicely finished and the general effect brought to mind Cole and Deuel's type 2-a.

A rim from the Keithsburg site had ordinary grit tempering and the usual red-brown color. Decoration showed about ten horizontal lines. Lip was notched on inner and outer edges alternately so that a waving resulted.

Among the Clear Lake pottery, not yet described or named as a type for this area, is a pottery which bears as the only, or chief decoration an imprint made with the edge of a cord-wrapped-paddle, for which the writer offers the name, Clear Lake Corded-Paddle-Edge. This decoration has previously been termed cord-wrapped-cylinder or cord-wrapped-stick but corded-paddle-edge is offered as more correctly descriptive, the cord-wrapped modeling paddle simply turned edgewise being more easily and more probably used than a second special tool.

The paddle-edge may be imprinted flatwise or edgewise, in the second instance leaving a lengthwise line in the center of imprint. Cord wrapping may be widely or closely spaced, and the cord may vary in size from medium to quite fine.

The pottery grades in weight from heavy to light. In general, the heavier compares in weight, paste, temper, texture, color and shape with Cole and Deuel's type 2, or Griffin's Naples Dentate Stamped, and the lighter weight comprises the rather thin ware bearing this decoration which Cole and Deuel placed in subtype 3-a.

In the heavier pottery the print may be used on upper rim, lip, or body. It may be but a short stroke repeated around the upper rim; generally the position is diagonal right-to-left, rarely vertical or diagonal left-to-right. It may appear as a small lip notching, which sometimes waves the lip. Occasionally it appears on the top or on interior of lip. Sometimes it covers the whole rim. It may appear in horizontal position. It may make a long continuous line and may occasionally be combined with incising in zoned designs. The boss is used with it frequently, and a punctate, less often. It is placed on both smooth and cord-roughened surfaces. Lips may be flat, horizontal, inward or outward sloped, occasionally overhanging.

In the lighter weight pottery the use of the imprint is limited to the simple upper rim, with a design or other exception extremely rare. The usual position is the oblique right-to-left. Imprint may notch lips. The vertical and the diagonal left-to-right positions are also infrequent in

this weight, as is an imprint on inner lip. The fingernail punctate is combined with the imprint in rare instances. The collar and channel sometimes occurs. The imprint is placed on a surface smooth to the shoulder, and often cord-roughened from the shoulder down. The wide-intervaled cord roughening, with the cord imprints sharp, distinct, and fine, so abundant at this site, often appears in this weight. Necks are vertical or flared outward. Lips are simple, flat, or rounded, horizontal, rarely rolled. Instances of cord roughening on lip and neckless forms occur as exceptions. Color is light brown or gray. The form is a wide-mouthed sloping shouldered jar with a conoidal base.

An interesting but puzzling occurrence is a rim with outer surface missing but with inner surface bearing this imprint and the rim seeming to show a corner.

The heavier pottery numbers around 100 rims and lower rims. The lighter weight includes over 450 rims but it seems probable that they represent a lesser number of pots since their general similarity and frequent small size have made it difficult to distinguish related ones.

BOTANY

INHERITANCE OF FOLIAGE VARIEGATION IN VARIEGATED ENGLISH ELM

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Inheritance of foliage variegation in variegated English elm, *Ulmus procera argenteo-variegata* (West.) Rehd., was observed on seedlings grown from seed of a single parent tree. Eighteen seedlings were obtained from an undetermined number of seeds which were planted May 22, 1940. Nine of the seedlings developed variegated foliage, while the remaining nine seedlings developed normal green foliage. Variegation began to appear on the first unfolding leaves when they were about ½ inch long. It increased in amount and in intensity on new leaves as they expanded during the growing season.

Variegation appeared as white to light green spots and stripes—a mosaic arrangement of green and white tissues—interspersed in the normal green tissues, fig. 1. White areas occurred where green pigment was absent in both the palisade cells and the spongy mesophyl. These white areas were visible on both the upper and lower surfaces of the leaves. Light green areas occurred where green pigment was present in the spongy mesophyl but was absent in the palisade cells. These light green areas were visible only on the upper surfaces of the leaves, except when the leaves were observed against a background of bright light.

The amount of variegation varied from a few white to light green areas on one or a few leaves of individual seedlings to numerous white to light green areas on many leaves of other seedlings. Variegation of the seedlings which had an abundance of white to light green areas, fig. 2, was similar in pattern and intensity to that of the parent plant, fig. 1.

Several investigators have reported that color abnormalities in the foliage of several plants are heritable. Emerson (2), studying blotch leaf of maize, and Burkholder and Miller (1), studying pseudo-mosiac of beans, found that these abnormalities are inherited as recessive factors. Parker (3) found that yellow-spot in beans is inherited as a single Mendelian factor and behaves as a simple dominant. Parker (4), Thompson (5), and Whitaker (6), studying certain foliage variegations in beans and lettuce, found that these abnormalities, due to chlorophyl deficiencies, were the result of cytoplasmic variation and that they could be transmitted only by a female parent—the parent contributing cytoplasm to the seed.

Because of the time required—several to many years would have to elapse before trees grown from seed would themselves produce seed—it has not been possible to analyse the method of inheritance by which variegation is transmitted by English elm. Because of the small number of seedlings observed, the apparent 1:1 ratio noted probably has no significance. From the studies cited above, that have been made with rapidly reproducing plants, it may be supposed, however, that variegation is transmitted by English elm as a cytoplasmic variation.

FIG. 1.—Variegated foliage of the parent tree showing the mosaic or blotched arrangement of the white and light green areas in the leaves. The amount or intensity of variegation varies greatly on different leaves of a single twig.

FIG. 2.—Variegated seeding showing variegation similar in pattern and intensity to that of the parent plant.

LITERATURE CITED

1. Burkholder, Walter H. and Albert S. Miller. Hereditary abnormalities resembling certain infectious diseases in beans. Phytopath. 16: 731-737. 1926.
2. Emerson, R. A. The inheritance of blotch leaf in maize. Cornell Univ. Agr. Exp. Sta. Mem. 70, 16 p. 1923.
3. Parker, M. C. The inheritance of a yellow-spot character in the bean. Jour. Heredity 24:481-486. 1933.
4. Parker, M. C. Inheritance of a leaf variegation in the common bean. Jour. Heredity 25:165-170. 1934.
5. Thompson, R. C. Genetic relations of some color factors in lettuce. U.S.D.A. Tech. Bull. 620. 1938.
6. Whitaker, Thomas W. The inheritance of chlorophyll deficiencies. Jour. Heredity 35:317-320. 1944.

ILLUSTRATED NOTES ON THE FLORA OF HENRY COUNTY

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These notes are based upon, and incidental to, a botanical survey being made by the writer of Henry County, one of a group of Mississippi Valley counties situated in the west-northwest part of Illinois. This project has claimed a great part of the writer's time and attention during the past 12 years, and is still continuing. To date some 1150 species, varieties, and forms have been found, including many rare plants and a few apparently not recorded heretofore from Illinois. These comments concern those found or observed for the most part during the 1945 collecting season.

Collomia linearis Nutt. (*Gilia linearis* (Nutt.) Gray of Gray, Man., ed. 7.) is a rare plant in Illinois, and seemingly of uncertain status. It has been reported from a number of counties, but always with few annotations as to its habitat or distribution. Deam reports it as having been found along railroad tracks in Indiana on one occasion. It is native on the west coast, and in California mountains it is found on dry slopes and flats up to at least the 8,500-foot level. Unfortunately, the writer never found the species there, although for eight years he traversed California mountain trails afoot, to the extent of about 5,500 miles, in quest of new plants, and has botanized in all the zones of plant life in that state, from the below sea level regions of the Salton Sea to the top of Mt. Whitney, the highest peak in the United States.

The first introduction of this plant to the writer was on June 25, 1935, when a few specimens were found in waste ground along railroad tracks about 1½ miles west of Geneseo. These plants have been under observation since that time, and a few specimens have gradually spread. However, this increase in abundance was not always immediately apparent. During the spring of 1943 it was necessary to make three visits to the station before a single plant could be found. My third visit was a determined one, however, and finally after diligent search the colony was found to be not only persisting, but, indeed, spreading. At least it had spread in one direction as a long narrow band under a wire fence, which, with dominant quack grass on one side and a farmer's plow on the other, seemed to be the line of least resistance.

My last revisit was made on June 19, 1945, practically ten years after the first few specimens were found. The colonies had increased in size and number to the extent that it is reasonable to assume the species is now, or soon will become, a part of the established flora of Illinois.

Lactuca pulchella (Pursh) DC. is also a rare plant in Illinois, and also, seemingly, of uncertain status. This blue-flowered lettuce is generally less than one meter high, prefers exposed situations, at least in Henry County, and has a pale or glaucous appearance, by which it is distinguished from the other blue-flowered species of *Lactuca* in the state. It is native in California where it occurs in montane valleys of the Sierra Nevada up to at least the 6,000-foot

level, and also in Utah and Nevada where it is found in the moist ravines and meadows of the pinyon, artemisia, and yellow pine belts. Deam does not report it for Indiana. In Illinois it has been collected by Umbach in or near Naperville, and there are one or two other reports of its occurrence in this state. On July 17, 1945 a large colony of it was found in waste ground along railroad tracks about one mile west of Alpha, in southwest Henry County. It has spread eastward as far as Maine, but from all reports, mostly along railroad tracks. More time will be required to determine its status in this state.

Froelichia gracilis (Hook.) Moq. seems to be another plant of uncertain status in Illinois. Inasmuch as the stem of this plant is often much divided near the base with many prostrate branches, it is easily distinguished in the field from the only other Illinois plant of the genus, *Froelichia floridana* (Nutt.) Moq. var. *campestris* (Small) Fern. (*Froelichia campestris* Small). From the paucity of occurrence records, the assumption has probably been rather general among Illinois botanists that the plant is rare in this state. My first specimens were found near Cambridge, July 18, 1938. Since that time it has been found near Geneseo, Atkinson, Orion, Alpha, and the village of Green River, always on railroad ballast, however, which might carry the presumption that the plant is not established. On September 9, 1945, however, a sizable colony was found in a dry rather sandy upland pasture field quite some distance from highway or railroad, and inasmuch as the first colony found near Cambridge is still persisting, the evidence suggests the probability that the species is now, or soon will become, established in Illinois.

Erysimum inconspicuum (Wats.) MacM. (*Erysimum parviflorum* Nutt. of Gray, Man., ed. 7), and distinguished in the field by its fine canescence and strongly ascending to nearly erect pods, is another rare plant in Illinois. It is native in the states of Utah and Nevada where it occurs in the valleys, and ascends the mountains to at least the level of the spruce belt. It has also spread eastward to eastern Canada and New England, but from all reports, always on railroad ballast. Deam cites two Indiana stations for it, also on railroad ballast. On July 24, 1945, a small colony of it was found on the cinders of a railroad siding at the east edge of Geneseo, where it undoubtedly is a plant of very recent introduction. It apparently is not established in Illinois, and from the evidence at hand, will not be for some time, if ever.

Another plant apparently of very recent introduction in Illinois is *Heterotheca subaxillaris* (Lam.) Britton & Rusby. This species much resembles *Chrysopsis villosa* (Pursh) Nutt., a psammophilous plant of rather frequent occurrence in Henry County, but may be distinguished from it by the achenes of the ray and disk flowers, which are quite markedly dissimilar. It is nearly ubiquitous in the southern states and Mexico, and is spreading northward. On September 17, 1944, a few plants were found along railroad tracks near the village of Green River, and they were still persisting at the time of my last revisit which was on September 9, 1945. Although the region has been botanized rather frequently, no specimens were seen prior to the above dates. Deam does not report it for Indiana, and the writer has never heard of its occurrence elsewhere in Illinois. More time will be required to determine its exact status in Illinois.

On July 1, 1945, in dense woodlands near the western limits of Henry County, the writer found a large colony of what appeared to be *Pedicularis canadensis* L. However, because the colony was so dense, a further investigation was made. When the roots were examined, many horizontal basal offshoots were found, some of them distinctly repent. Inasmuch as I had never seen such root structure in typical *Pedicularis canadensis*, the specimens were sent to Dr. M. L. Fernald, director of the Gray Herbarium. He recognized the root variation as of varietal significance, and the new plant was dedicated to the writer with the name of *Pedicularis canadensis* L. var. *Dobbsii* Fern. (For a full description of the plant, with two plates, see Rhodora 48: 59-60. 1946.)

Just why *Lycopus asper* Greene should be so rare in Illinois is not at the moment clear. It is undoubtedly a native plant in this state, and with its pubescence of flat, multicellular hairs and rather short internodes, these often less than 2 cm. long, it is easily distinguished in the field from all other species of Illinois *Lycopus*. On July 27, 1945, in Edford Township, a few flowering plants were found on the low moist rather open margin of an old pond about ¾ mile west of Illinois-Mississippi Canal Lock No. 25. The station was revisited two days later, and many more plants were found. Deam does not report it for Indiana, and Stony Island in or near Chicago is the only other station of record for its occurrence in Illinois which has come to the writer's attention.

The Russian-olive, *Elaeagnus angustifolia* L., a native of southern Europe and Asia and which has become established along canals in Nevada, should scarcely be looked for in Illinois, but on June 16, 1945 a single tree was found on a rather high embankment of the Geneseo Creek, just to the south of Geneseo. It is distinguished from other Illinois trees by its striking silvery appearance, together with its alternate leaves and the four stamens of the flower. A day or two prior to the above date, the species was found on a nearby shoulder of U. S. Route 6, where it was probably planted by the state highway department. It is reasonable to assume the species may increase in abundance, and may possibly become established in the state. Furthermore, in my opinion, the planting of trees and shrubs along Illinois highways is going to play an increasingly important part in the distribution of plant life in the state, and must be considered when unusual plants are found. The writer has secured from the Henry County superintendent of highways a list of such species being planted along county aid roads, which list should help in an intelligent appraisal of this interesting situation.

SILOAM SPRINGS STATE PARK[1]

ROBERT EVERS[2] AND C. CLAYTON HOFF[3]
Quincy, Illinois

The recently created Siloam Springs State Park is of general interest to residents of Illinois and of special interest to people residing in the west central part of the State. As few people are acquainted with the park or, indeed, are even aware that the park exists, the writers have assumed the responsibility of directing attention to some of the more interesting aspects of the park, its history, and its present condition.

Siloam Springs State Park is located in the southwest part of Brown County and the eastern part of Adams County, with approximately one-half of the park in each county. The park may be reached by automobile from U. S. Route 24, leaving the route in the vicinity of Clayton and traveling nearly 12 miles south. It may also be reached over a road about six miles long from State Route 104, turning off the route between Liberty and Chambersburg. The local roads are not greatly improved at present and some difficulty may be experienced during very wet weather. In the summer and early fall, however, the dirt and gravel roads are fairly good.

HISTORY

The Siloam Springs area has long been used for recreational purposes, being very popular between 1880 and 1900, but gradually declining in popularity during the more recent years. The early records relative to the park area are concerned chiefly with the curative nature of the water from the springs. According to a newspaper article (*Quincy Daily Whig*, May 28, 1882), the people of Siloam Springs reported the water helpful in the treatment and mitigation of a number of diseases. The water was reported to have cured several individuals of such diseases as cancer and kidney trouble. These reports in part may have been promoted by a business venture since, in 1880, the property in the region of Siloam Springs was purchased by Mr. Quincy Burgesser, who in 1881 began to develop the area for recreation and in 1882 began to build a hotel. Requests for reservations at the hotel were so numerous that it was decided, after construction had already been started, to increase the size of the hotel far beyond the original plans. This caused some delay and the hotel did not open until 1884.

The immediate popularity of the hotel and resort is indicated by newspaper articles in later issues of the *Quincy Herald Whig*. According to the register of the Forest Hotel, the early visitors included Phil Armour, founder of the Armour Packing Company, who was registered on June 28, 1887; C. E. and A. G. Ringling of circus fame,

[1] The writers wish to thank Mrs. H. Swope of the *Quincy Herald Whig* for making available newspaper articles relative to Siloam Springs State Park. The writers also wish to express their gratitude to Mr. William F. Gibbs, Representative to the General Assembly, for information, including a map, concerning the size and location of the park.

[2] Quincy High School to September 28, 1946. Now Assistant Botanist, Illinois State Natural History Survey, Urbana, Ill.

[3] Quincy College to June 1, 1946. Now Professor of Zoology, Colorado Agric. and Mech. College, Ft. Collins, Colo.

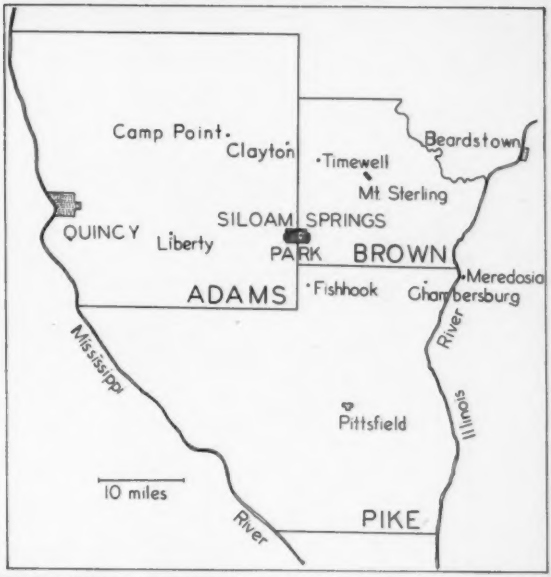
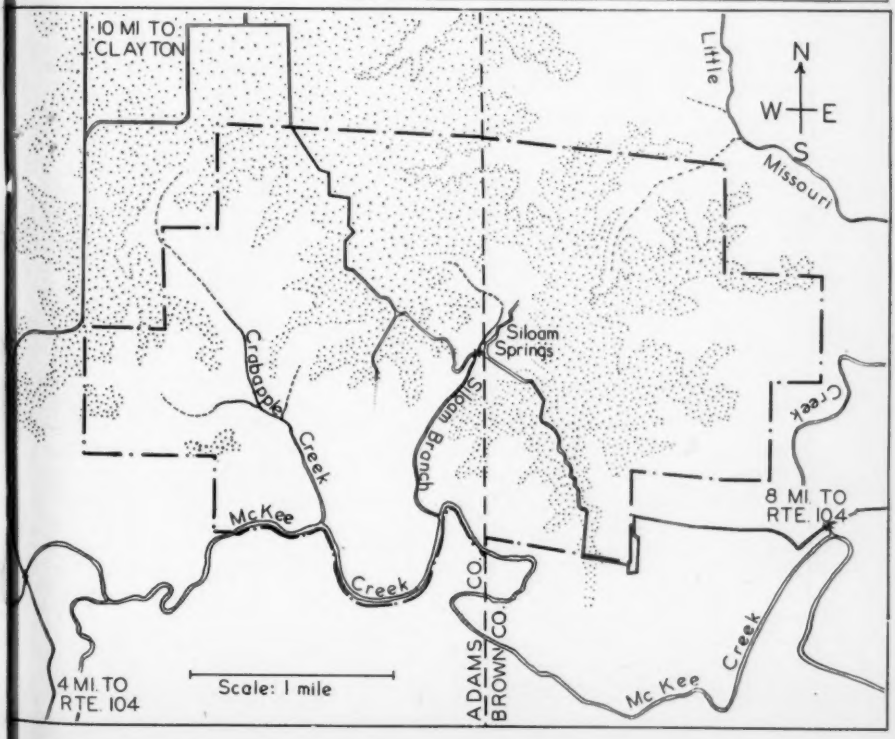


FIG. 1.—Map showing the location of Siloam Springs State Park in Adams and Brown Counties.

FIG. 2.—Map of Siloam Springs State Park showing the streams and roads. The heavy boundary shows the limits of the park. The upland areas and the bluff tops are indicated by stippling. In making the map, the lower limit of the upland area was arbitrarily taken at the 600-foot contour line in the region west of Crabapple Creek and at the 700-foot contour line in the region west of Crabapple Creek.



who were guests beginning October 23, 1887; and P. T. Barnum, also of circus fame, who visited the hotel on July 28, 1888. After this time, the popularity of the hotel gradually declined, perhaps as a result of several changes in management.

The history of the plan to create a park and public recreation area at Siloam Springs begins perhaps in 1935, when the Siloam Recreation Club was founded and incorporated for the purpose of building a club house and improving the grounds, and in addition, for the purpose of interesting state and federal bureaus in fostering a park or game refuge in the area. On Sunday, August 29, 1937, newspaper accounts (*Quincy Herald Whig*) indicated that the Recreation Club had succeeded in renovating the hotel, purchasing playground equipment, and generally improving the area for recreation purposes. On the same date, a gravel road to the springs was dedicated. In the years immediately following 1935, the club grounds were leased by the day to such organizations as churches, the Y. M. C. A., and the Boy Scouts.

The park area remained in private hands for a few years until, in 1940, an agreement was reached with the State of Illinois to create a state park. Citizens of the City of Quincy, as well as local residents of Brown and Adams Counties, raised money to match state funds for the purchase of the necessary land. At the present time, more than one-half of the proposed 3472 acres has been acquired and additional land is being secured as rapidly as conditions permit.

As land is at present still being purchased, little work has been done towards improvement of the park. The old hotel was sold at auction in November 1943, to a private individual, who tore down the structure to secure the building materials. Plans have been made to build better roads to the area, with one road entering from the west, one from the east, and one from the north. In some instances, this means only the improvement of existing roads rather than the development of new roads. Included in the present plans for the park is the development of an artificial lake, to be made by damming the waters of Crabapple Creek, a branch of McKee Creek which flows along the south border of the park. This dam will be located in the western one-third of the park and will furnish a fairly extensive water area for recreational purposes.

NATURAL HISTORY

The Siloam Springs area is well suited for a park. Topographically, the land is rough, being cut in many places by series of gullies or ravines, many of which are more than 100 feet deep. These ravines are so extensive that few areas of the park are level. The rough topography of the park is associated with McKee Creek and its tributaries, the ravines having been cut by water flowing over the easily eroded Illinoian glacial drift. In the lower portions of the ravines and along McKee Creek and its large tributaries, the erosion has exposed the Pennsylvanian and Mississipian rocks.

Associated with this topography, as is usually the condition in central and western Illinois, is the deciduous forest, which covers the immediate vicinity about Siloam Springs. The forest belongs to the oak-hickory association and appears to be near the margin of this association, since the prairie is extensive in northern Brown and northeastern Adams counties.

Although the entire park area was originally forested, the trees were early removed from areas that could

FIG. 3.—The larger spring house at Siloam Springs.

be cultivated and used for farming. The level bluff tops especially have been cleared. The deep ravines and gullies, on the other hand, as well as some of the hillsides were not suited for farming, and as a result, the original biota has been less disturbed. The entire area, however, has undergone considerable and serious change from the original condition. From the general nature of the vegetation, it is apparent that many of the trees were cut from the ravines and that the ravines were used as pasture. The pasturing of the land, logging operations, and farming have no doubt hastened erosion in this area and made the topography more rough.

PRESENT FLORA OF SILOAM SPRINGS

Although the Siloam Springs State Park is a part of the oak-hickory association of the deciduous forest, there has been sufficient interference with and disturbance of natural conditions to make profitable a few notes on the present conditions of the biota. The most seriously altered areas are to be found on the bluff tops, where there are a few more or less level areas. Here the trees were removed so that the land might be tilled. Most of these upland fields now have been out of cultivation for one or more years. In some of these fields may be found, as the first stage in seral succession, dense and almost pure stands of goldenrod (*Solidago*) and asters (*Aster*). In fields that have remained idle for a longer period of time, there may be found various grasses, and in some places such shrubs as smooth sumac (*Rhus glabra* L.). These plants appear to become es-

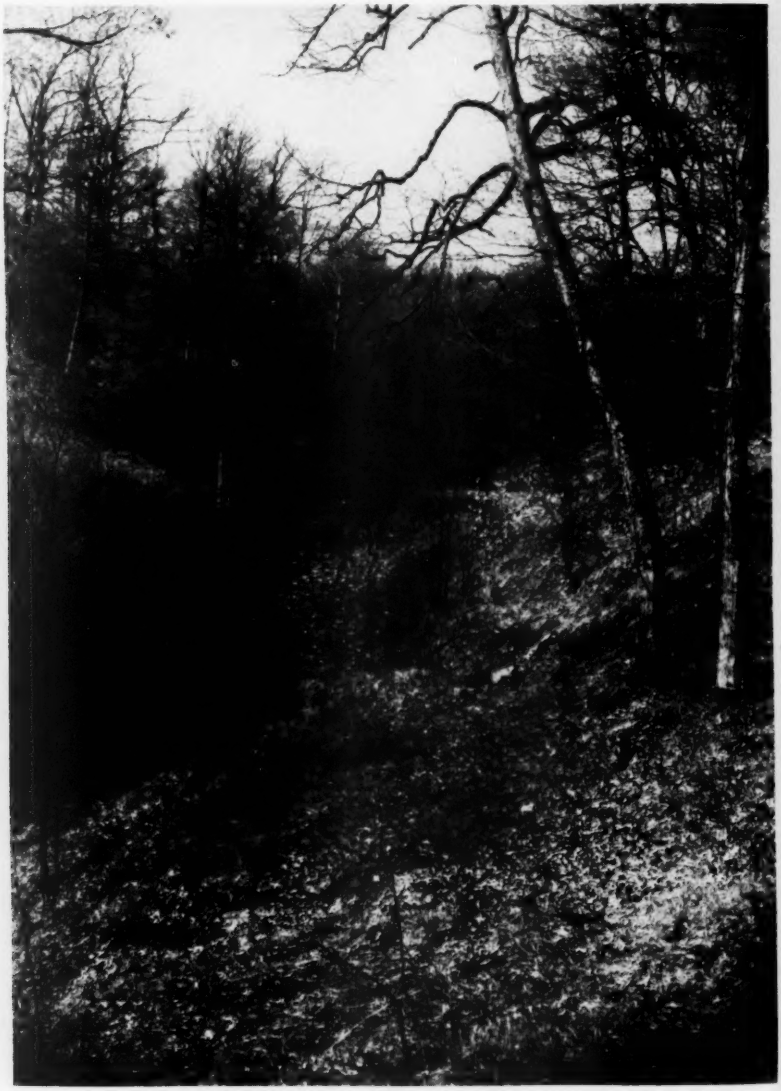


FIG. 4.—View of a typical ravine at Siloam Springs.

tablished very soon after the land is no longer cultivated. In the marginal zone between the idle fields and the wooded areas may be found, in addition to the smooth sumac, such shrubs as the prairie willow (*Salix humilis* Marsh.) and the fragrant sumac (*Rhus aromatica* Ait.) and small trees and sapplings of sassafras and hickory. Also in this marginal zone, Indian grass (*Sorghastrum nutans* (L.) Nash.) and the bluestem (*Andropogon furcatus* Muhl.) are somewhat abundant.

The climax upland woods is composed predominantly of the shagbark hickory (*Carya ovata* (Mill.) K. Koch), the white oak (*Quercus alba* L.), and the red oak (*Q. borealis* Michx. f.), along with scattered sassafras(*Sassafras albidum* (Nutt.) Nees.), ironwood or hop-hornbeam (*Ostrya virginiana* (Mill.)K. Koch), and numerous seedlings of the rock maple (*Acer saccharum* Marsh.). In the Adams County area, the post oak (*Quercus stellata* Wangh.) is abundant in the upland woods. The shrubs in this habitat are the rose (*Rosa carolina* L.), the fragrant sumac, the smooth sumac, and the gooseberry (*Ribes missouriense* Nutt.). In the herb layer of the climax forest is found the blue-eyed grass (*Sisyrinchium albidum* Raf.) as well as the gromwell (*Lithospermum canescens* (Michx.) Lehm).

The dominant trees of the upper part of the ravines are similar to those of the upland climax forest. Here are found abundantly the red oak, the white oak, the black oak (*Quercus velutina* Lam.), and the shagbark hickory. Scattered in some areas are found the flowering dogwood (*Cornus florida* L.). On the side of one ravine not far below the upland forest was found a somewhat extensive area covered with the hop-hornbeam. That this particular area had been cleared is indicated by the great number of old stumps. At present, the hop-hornbeam appears to be the dominant woody plant in this local area and probably is important in succession.

Of considerable more botanical interest than the upland forest and the flora of the upper parts of the ravines, is the plant life of the bottom and lower sides of the ravines. Here is an area of fairly dense shade, high humidity, and considerable soil moisture. Such areas are well adapted to the growth of ferns, especially brittle fern (*Cystopteris fragilis* (L.) Benth.), the Christmas fern (*Polystichum acrostichoides* (Michx.) Schott.), and the maidenhair (*Adiantum pedatum* L.). The last is found in the bluff woods through the entire park area. The silvery spleenwort (*Diplazium acrostichoides* (Sw.) Butters) is relatively abundant and in the summer months attracts attention when its silvery fronds wave in the breeze. The purple trillium (*Trillium recurvatum* Beck), the bloodroot (*Sanguinaria canadensis* L.), the mayapple (*Podophyllum peltatum* L.), the liverleaf (*Hepatica acutiloba* DC), and the spring beauty (*Claytonia virginica* L.) are common as are the rue anemone (*Anemonella thalictroides* (L.) Spach.) and the strawberry (*Fragaria virginiana* Duch.). The bird-foot violet (*Viola pedata* L.) is also abundant, occurring in extensive and nearly pure stands towards the upper margin of some of the ravines. In one location east of the spring house in the old village of Siloam, the bird-foot violet was found to cover approximately two thousand square feet with an average of forty blooms per each square foot in this almost pure stand. This violet is commonly associated with abundant growth of mosses, especially the

hairy cap moss (*Polytrichum commune* L.).

At the base of the bluffs and near the bottoms of the ravines, especially where the ravines open onto the flood plains, may be found other plants not mentioned as typical of the higher parts of the ravine sides. These plants include the white elm (*Ulmus americana* L.), the buckeye (*Aesculus glabra* Willd.), the sycamore (*Platanus occidentalis* L.), and the black willow (*Salix nigra* Marsh.). In these lower parts of the ravines, the elderberry (*Sambucus canadensis* L.) and the burning bush (*Euonymous atropurpurea* Jacq.) are common shrubs. At lower levels, along the streams and in the flood plains may be found still other plants. Among these is the closed gentian (*Gentiana andrewsii* Griseb.). A few specimens of this species were found in bloom along the Siloam branch (in Brown County) of McKee Creek during September.

Other local areas and associations are also of interest. For instance, the cliff brake (*Pellaea glabella* Mett.) was collected from the rocks at the location of the proposed lake. Unfortunately, time did not permit a thorough study of the plants of the rock outcrops, the most extensive of which are along McKee Creek and its tributary Crabapple Creek in Adams County. Further collection is planned in order to secure more information on the flora of this habitat, especially in the area that will be inundated by the proposed lake.

Besides being of interest as far as the higher plants are concerned, the park site should be of interest to students of the lower plants. In the ravines on decaying logs and tree stumps are found many kinds of Myxomycetes and fleshy fungi. Mosses are abundant, and the interested student of bryology should profit much by exploring the Siloam Springs Park area.

Specimens of most of the plants mentioned as occurring in Siloam Springs State Park are to be placed in the herbarium of the Department of Botany of the University of Illinois and also in the herbarium of the Illinois State Natural History Survey.

CONCLUSION

As a fitting conclusion, it seems not at all out of place to suggest the complete preservation of certain local areas within the park. As already mentioned, the semi-level uplands have been so much altered that the original biota has been completely destroyed. Little can be done to restore these formerly tilled areas to the primitive condition. On the other hand, the deeper ravines, gullies, and some of the hillsides still contain remnants of the original fauna and flora. These areas, provided meddling improvement is prohibited, may long serve as an indication of the original biotic conditions To preserve these areas, the trees and gross vegetation must be left undisturbed and the areas must no longer be used as pasture for livestock. With suitable care, many of the smaller and less disturbed local areas of the park may be adequately conserved for the future use and enjoyment of biologists, naturalists, and nature lovers.

UTILIZATION OF VARIOUS CARBOHYDRATES BY *STREPTOMYCES GRISEUS* FOR PRODUCTION OF STREPTOMYCIN AND GROWTH

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The development of a chemically defined medium (4, 5) for growth and production of streptomycin by *Streptomyces griseus*, (Krainsky) Waksman and Henrici, 1943, provides accurate methods for nutritional studies with this microorganism. This synthetic medium, consisting of simple organic and inorganic chemicals furnishes critical tests for the utilization of other substance when substituted for various constituents because the nutritional factors are controlled and also because in the absence of any constituent growth is greatly diminished and streptomycin production is reduced or lacking. With these exact methods available, the utilization of various carbohydrates by *S. griseus* was studied by substituting these for glucose of the original medium. The results of this study and a description of materials, methods, and experiments are reported herein.

METHODS* AND MATERIALS

The culture of *S. griseus* used throughout these studies was secured from Waksman (6) and is his strain number 9 from No. 18-16 originally obtained from heavily manured field soil (3, 7).

Streptomycin was estimated by the paper disc-plate assay method (2) against *Bacillus subtilis* in Bacto-Streptothricin Assay Agar and reported as units per ml. (2).

H-ion concentrations were determined electrometrically with a Beckman pH meter.

Growth of the microorganism was determined by weighing the vacuum dried mycelial mat that developed on the surface of the liquid medium.

Growth conditions were provided by an air-conditioned culture room in which the air was exchanged and the temperature and humidity were automatically controlled at 26°C. and 40 percent relative humidity (dry bulb 78-79°F. and wet bulb 60-65°F.). The cultures were grown for ten days in 125 mls. Erlenmeyer Pyrex flasks containing 50 mls. of medium which was 2 cm. deep with an air surface of 0.66 cm^2 per ml. of liquid.

Inoculum for seeding the media was obtained by growing the fungus for 7-10 days on 200 ml. of beef-extract liquid medium in rectangular, two-quart milk bottles laid horizontally (air or mat surface of 192 cm^2 per bottle). Inoculum on this medium was utilized to prevent any selective adaptation of the fungus to the special medium through repeated transfers. The mat, consisting of spores and mycelium, was added to sterile distilled water (one mat per 100 ml.) and thoroughly broken up by means of a Waring blender operated at high speed for 10 seconds. A small amount (4 to 5 drops) of this inoculum was introduced aseptically into each flask of medium. To avoid submergence of spores the inoculum was applied to the glass surface of tilted flasks just above the medium. This permitted the spores

* The methods are similar to those used in developing the synthetic medium (4, 5).

to remain on the surface of the liquid, a condition which is apparently necessary for growth. Thereafter, the inoculated flasks were stationary until the medium was assayed for streptomycin.

The basal synthetic medium (4, 5) was as follows: KH_2PO_4 2.38g; K_2HPO_4 . $3H_2O$ 5.65g; mg. SO_4. $7H_2O$ 1.0g; $ZnSO_4$. $7H_2O$ 0.0115g; $FeSO_4$. $7H_2O$ 0.0111g; $CuSO_4$ 0.0064g; MnCl . $4H_2O$ 0.0070g; and amonium lactate 5.4g. per 1000 mls. of distilled water. The H-ion concentration was pH 6.95.

The carbohydrates used were: l-arabinose, l-xylose, rhamnose, d-mannose, d-galactose, maltose, lactose, callibiose, melibiose, trehalose, raffinose, melezitose, mannitol, dulcitol, dextrin, inulin, glycogen, salicin and gum acacia.

EXPERIMENTS AND RESULTS

To determine what carbohydrates were utilized by *Streptomyces griseus*, experiments were designed to substitute each of the carbohydrates for glucose in the synthetic medium prior to sterilization at 15 lbs. pressure for 20 minutes. With the experiments in six replications a total of 300 ml. of medium was used with each carbohydrate and this was divided accurately into 50 ml. portions. (Approximately 0.1 percent of powdered calcium carbonate was added to three of each series. As there was but little effect upon growth and streptomycin production, the results of the two series were combined). Monosaccharides were added in 0.05 molar concentrations and polysaccharides were used in 0.025 molar concentrations. Those

TABLE 1.—THE EFFECT OF CARBOHYDRATES IN A SYNTHETIC MEDIUM ON GROWTH, PRODUCTION OF STREPTOMYCIN AND CHANGES IN H-ION CONCENTRATION BY *Streptomyces Griseus* IN SURFACE CULTURE

Carbohydrate	Concentration	Units of Streptomycin per ml.	Weight of Mat. per 300 ml.	pH
l-Arabinose	0.05 M.	0	188.9	7.86
l-Xylose	0.05 M.	15.1	701.5	7.04
Rhamnose	0.05 M.	11.1	448.5	7.52
d-Mannose	0.05 M.	42.3	624.6	7.50
d-Galactose	0.05 M.	34.6	724.0	7.32
Maltose	0.025M.	62.3	645.1	7.28
Lactose	0.025M.	11.1	363.5	8.14
Cellibiose	0.025M.	41.5	512.1	7.41
Melibiose	0.025M.	10.5	269.6	8.34
Trehalose	0.025M.	11.8	443.8	7.96
Raffinose	0.025M.	10.7	337.8	8.27
Melezitose	0.025M.	9.7	330.4	8.38
Mannitol	0.05 M.	42.2	452.6	7.83
Dulcitol	0.020M.	9.1	192.0	8.35
Dextrin	0.5%	26.1	423.6	7.76
Dextrin	1.0%	40.5	641.3	7.04
Inulin	0.5%	13.8	130.4	8.27
Inulin	1.0%	18.7	91.9	8.31
Glycogen	0.5%	18.0	129.3	7.66
Glycogen	1.0%	25.35	145.4	7.23
Salicin	0.5%	10.3	.....	8.08
Salicin	1.0%	8.0	.....	8.11
Gum acacia	0.5%	13.8	285.9	8.19
Gum acacia	1.0%	12.8	230.4	8.19
None	.....	10.3	241.6	8.19

compounds of which the molecular weights were not known were added in both 0.5 percent and 1.0 percent concentrations. At the end of the 10-day growth period the streptomycin was assayed and H-ion concentration was determined in the medium of individual flasks. The amount of growth was determined by the dry weight of the six combined mycelial mats. The results of this preliminary survey given in Table 1 (average of six flasks) show that d-mannose, d-galactose, maltose, cellibiose, mannitol and dextrin supported good growth of the organism as well as good production of streptomycin. l-Arabinose, l-xylose, rhamnose, lactose, melibiose, trehalose, raffinose, melezitose, dulcitol, inulin, glycogen, salicin and gum accacia gave little if any increase in growth or steptomycin production.

Since our interest was chiefly in streptomycin production, only those compounds giving relatively good production were selected for further study. These were: d-mannose, d-

TABLE 2.—THE RELATIONSHIP OF CARBOHYDRATE CONCENTRATION IN A SYNTHETIC MEDIUM TO GROWTH, PRODUCTION OF STREPTOMYCIN, AND CHANGES IN CONCENTRATION BY *Streptomyces Griseus* IN SURFACE CULTURE

Carbohydrate	Concentration	Units of Streptomycin per ml.	Weight of Mat. per 300 ml.	pH
d-Mannose	0.01 M.	23	390.2	8.10
	0.03 M.	68	464.2	7.95
	0.05 M.	101	699.4	7.74
	0.08 M.	99	780.2	7.45
	0.10 M.	82	924.2	7.35
d-Galactose	0.01 M.	22	323.2	8.10
	0.03 M.	42	503.2	7.93
	0.05 M.	49	653.5	7.85
	0.08 M.	59	788.1	7.60
	0.10 M.	63	927.4	7.40
Maltose	0.01 M.	18	407.3	8.06
	0.03 M.	62	781.9	7.83
	0.05 M.	106	1,083.5	7.37
	0.08 M.	86	1,476.8	6.84
	0.10 M.	68	1,615.0	6.54
Cellibiose	0.01 M.	59	603.6	7.67
	0.03 M.	112	800.8	7.60
	0.05 M.	79	1,100.9	6.92
Mannitol	0.01 M.	22	332.4	8.06
	0.03 M.	57	631.9	7.78
	0.05 M.	101	802.5	7.49
	0.08 M.	50	895.0	6.52
	0.10 M.	69	1,319.6	6.72
Dextrin	0.5%	31	593.7	7.72
	1.0%	73	952.4	7.19
	2.0%	66	1,356.6	6.39
	3.0%	24	1,406.1	5.82
	4.0%	17	1,280.7	5.97
None	.....	18	160.5	8.12

galactose, maltose, cellibiose, mannitol and dextrin. To determine the optimal concentrations for production of streptomycin and growth dextrin was employed at 0.5, 1.0, 2.0, 3.0 and 4.0 percent concentrations, and the others were all used at 0.01, 0.03, 0.05, 0.08 and 0.10 molar concentrations. Three hundred mls. of medium equally divided into six flasks were used at each concentration. At the end of the 10-day growth period streptomycin was assayed and the weight of mycelial mat and the H-ion concentrations were determined. These results are shown in Table 2.

DISCUSSION

It is evident from the results of the first part of the studies shown in Table 1 that some carbohydrates may be substituted for glucose in this medium and that they give good production of streptomycin and growth, but that others are not utilized by the organism.

The relationship of streptomycin production to concentration of certain carbohydrates is illustrated graphically: figure 1, d-mannose; figure 2, d-galactose; figure 3, maltose; figure 4, cellibiose; figure 5, mannitol; figure 6, dextrin. With mannose the peak of streptomycin production as shown by the curve occurred at a concentration somewhere between 0.05M and 0.08M. Using d-galactose as the carbohydrate, streptomycin production steadily increased with the concentration of galactose up to the highest concentration used (0.1M). Whether production would have continued to increase to even higher levels before it started to decrease with increasing concentrations of sugar was not indicated. Maltose gave a peak production at a concentration near 0.05M, and at higher concentrations the amount of streptomycin decreased. With cellibiose maximum production of streptomycin occurred at 0.03M concentration, which is about

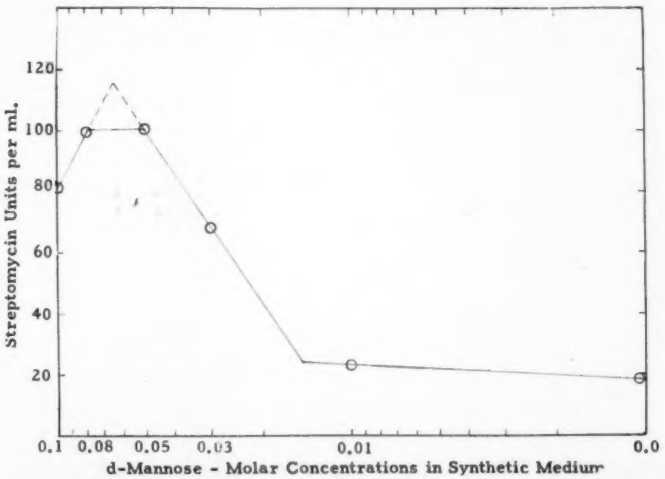

FIG. 1.—Relation between Streptomycin production in units per ml. and molar concentrations of d-mannose.

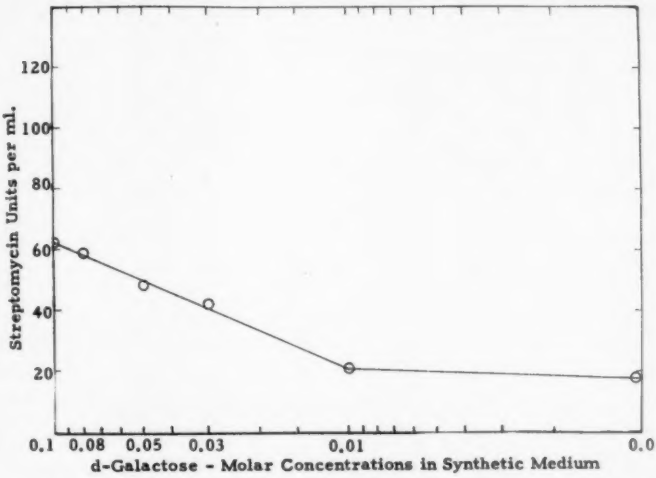

FIG. 2.—Relation between Streptomycin production in units per ml. and molar concentrations of d-galactose.

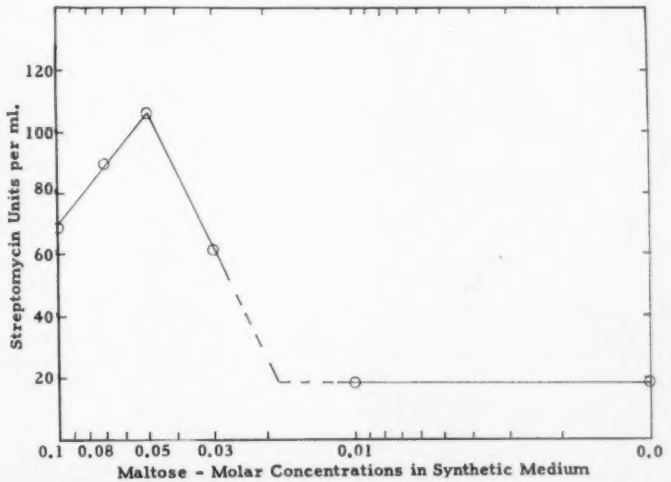

FIG. 3.—Relation between Streptomycin production in units per ml. and molar concentrations of maltose.

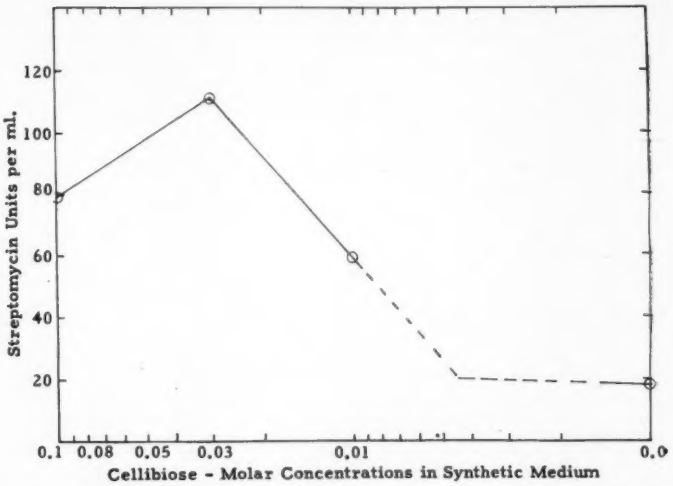

FIG. 4.—Relation between Streptomycin production in units per ml. and molar concentrations of cellibiose.

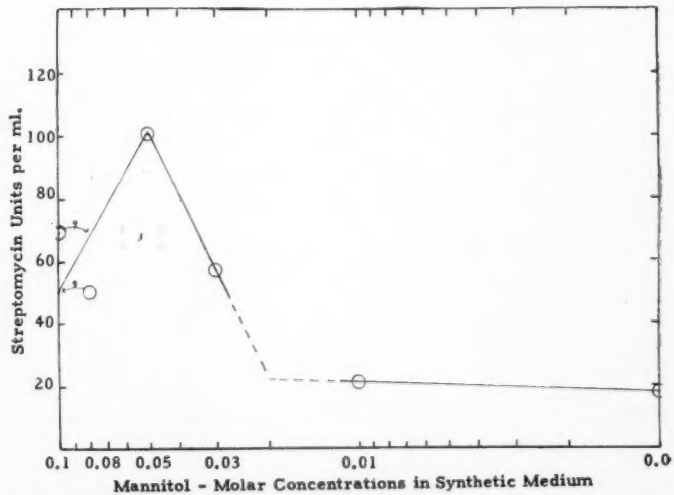

FIG. 5.—Relation between Streptomycin production in units per ml. and molar concentrations of mannitol. (.08 and .1 molar values were probably reversed by error in numbering).

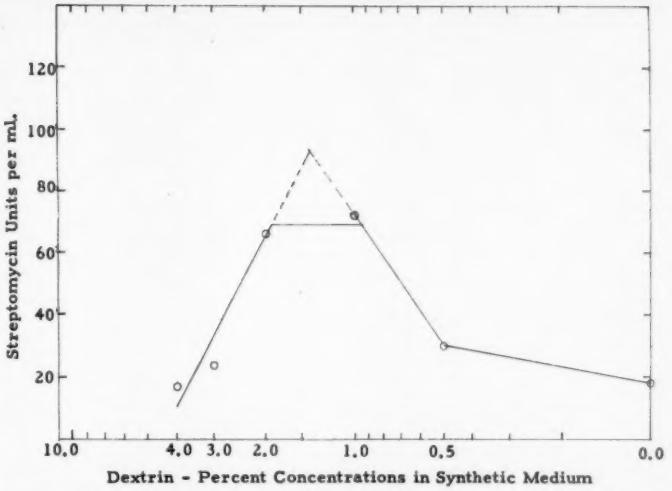

FIG. 6.—Relation between Streptomycin production in units per ml. and percentage concentrations of dextrin.

one-half the concentration (0.05M) of the more favorable monosaccharides necessary for the peak. It is interesting that the peak in production for maltose and the monosaccharides occurred at the same concentrations, but about twice the concentration of cellibiose necessary for the peak production of streptomycin. Since maltose and cellibiose are similar except for the alpha and beta linkage respectively between the two glucose units, the results suggest that the organism does not break the alpha linkage, but utilizes the maltose through direct fermentation as mentioned by Leibowitz and Hestrin (1). With cellibiose the organism apparently is able to break the beta linkage to form two molecules of glucose, and thus would need a concentration only half that of maltose for maximum production. Mannitol gave a peak production of streptomycin at a concentration between one and two percent.

The relationship between growth and production of streptomycin at various concentrations is similar with all the carbohydrates studied. The peak for streptomycin was reached at a concentration from 0.03M to 0.05M, but the weight of the mycelial mat continued to increase up to the highest concentrations used in the experiments. Dextrin is an exception to this in that maximum growth was obtained at concentration of 3.0 percent and decreased at a higher concentration. Figure 7 illustrates graphically the relationship between streptomycin units per ml., weight of mycelial mat and pH at the concentrations of maltose used. The streptomycin units per ml. rise rather sharply to a maximum of 106 at 0.05M concentration and gradually decrease to a value of 68 at a concentration of 0.1M. The weight of mycelial mat increases steadily with increased concentrations of sugar. The weight of mycelial mat was greatest (1,615 mg.) at 0.1M maltose and probably would have continued to rise at higher concentrations.

In all cases with good production of streptomycin there was a white,

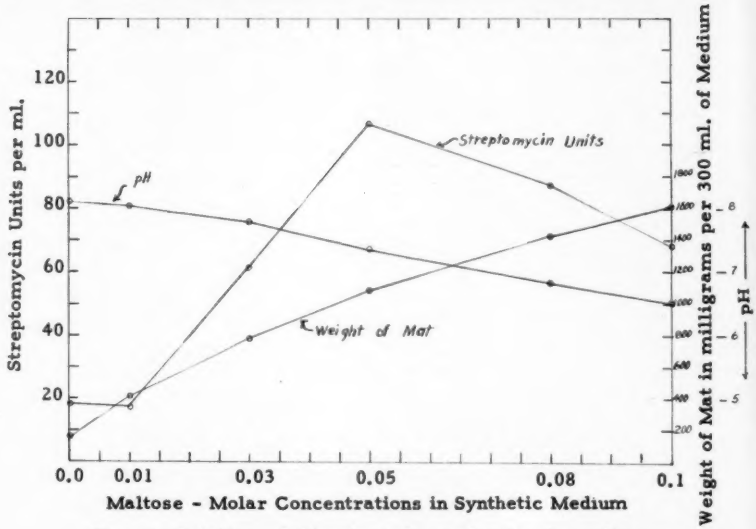

FIG. 7.—Relation of Streptomycin production in units per ml., weight of mycelial mat, and pH, to molar concentration of maltose.

cottony aerial growth. At higher concentrations of dextrin the organism produced a waxy growth that had a tendency to submerge.

SUMMARY

1. *Streptomyces griseus* in a chemically defined basal medium utilized d-mannose, d-galactose, maltose, cellibiose, mannitol, and dextrin for production of streptomycin and growth.

2. It does not utilize l-arabinose, l-xylose, rhamnose, lactose, melibiose, trehalose, raffinose, melezitose, dulcitol, inulin, glycogen, salicin or gum acacia.

3. The optimum concentrations for streptomycin production from the monosaccharides utilized and maltose appear to be between 0.05M and 0.08M. With cellibiose this optimum concentration is near 0.03M.

4. Maximum growth occurs at a higher concentration of carbohydrate than the optimum concentration for maximum production of streptomycin.

REFERENCES

1. LEIBOWITZ, J. AND S. HESTRIN. Alcoholic fermentation of the aligosaccharides. Advances in Enzymology *5*:87-127, 1945.
2. LOO, Y. H., P. S. SKELL, H. H. THORNBERRY, JOHN EHRLICH, J. M. MCGUIRE, G. M. SAVAGE AND J. C. SYLVESTER. Assay of streptomycin by the paper-disc plate method. Jour. Bact. *50*: 701-709, 1946.
3. SCHANTZ, ALBERT, ELIZABETH BUGIE, AND S. A. WAKSMAN. Streptomycin, a substance exhibiting antibiotic activity against gram-positive and gram-negative bacteria. Proc. Soc. Exp. Biol. Med. *55*: 66-69, 1944.
4. THORNBERRY, H. H. Nutrient requirements of an antibiotic soil fungus, *Streptomyces griseus* (Krainsky) Waksman and Henrici. Phytopathology *36*: 412, 1946.
5. THORNBERRY, H. H. AND H. W. ANDERSON. Synthetic medium for *Streptomyces griseus*, and the production of streptomycin. (In press).
6. WAKSMAN, SELMAN A. Letter Sept. 1. 1944 to H. W. Anderson, University of Illinois.
7. WAKSMAN, SELMAN A. AND ALBERT SCHANTZ. Streptomycin—a review. Jour. Amer. Pharm. Assoc., Practical Pharm. Edition *6*: 308-321, 1945.

A KEY TO THE GENERA OF COMMON WOODS

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The accompanying key for the identification of some of our common commercial woods was constructed as a teaching device. This key uses all of the principal characteristics of non-porous, ring-porous, and diffuse-porous woods that the student needs to know to understand the structure of woods, and the sections necessary for observation and the identity of all the types of cells in their three dimensions.

In the experience of the writer, a short key of this type is a useful tool because even beginning students with the help of the instructor can become acquainted with wood structure, reasons for the "grain" of wood, and be able to readily identify several kinds of woods. Students who learn to use such a key can quickly learn to use the larger keys.

1. Wood non-porous (no water tubes) 2
1. Wood porus (i.e., there are water tubes, tracheae) 9
2. Resin ducts both horizontal and vertical in wood 3
2. No resin ducts (except wound ducts in tangential groups) but resin cells present in wood except in fir 6
3. Tracheids with spiral markings ..... *Pseudotsuga* (Douglas Fir)
3. Tracheids without spirals or with only occasional spirals 4
4. Cells bordering resin ducts (epithelial cells) thick-walled; ray tracheid walls smooth; biseriate rays very sparse and scattered ..... *Picea* (Spruce)
4. Cells bordering resin ducts (epithelial cells) tearing easily, i. e., thin-walled 5
5. Ray tracheids smooth-walled, 1 to 2 simple pits per cross-field ..... *Pinus* (White Pine)
5. Ray tracheids with rough or reticulate walls (dentate), 3 to 6 simple pits per cross-field ..... *Pinus* (Pitch, Long-leaf or Short-leaf Pine)
6. No resin cells or ducts in wood (except occasional wound ducts that are widely separated and sporadic) ..... *Abies* (Balsam Fir)
6. Resin cells in wood irregularly scattered 7
7. Wood aromatic and variegated in color; bordered pits in one row in tracheids (rarely in two rows); rays uniseriate and entirely of parenchyma ..... *Juniperus* ("Red Cedar")
7. Wood not aromatic, usually an even color; bordered pits commonly in two rows in radial walls of tracheids, especially in spring wood 8
8. Heartwood light red to deep cherry-brown; abundant resin cells; bordered pits in tracheids in one to three rows, commonly two; rays uniseriate with some partly biseriate ..... *Sequoia* (Redwood)
8. Heartwood yellowish-brown to dark-brown to almost black; when rubbed, wood feels as if it had been impregnated with paraffin; resin cells abundant; bordered pits in tracheids in 1 to 4 rows, mostly 3 ..... *Taxodium* (Bald Cypress)
9. Wood ring-porous 10
9. Wood diffuse-porous 16
10. Wood with irregular-shaped radial areas of wood parenchyma; tangential parenchyma uniseriate 11
10. Wood without radial parenchyma but with tangential parenchyma 13
11. Both large and small xylem rays present, i. e., uniseriate and multiseriate rays present 12
11. Xylem rays all fine (uniseriate) ..... *Castanea* (Chestnut)

12. Water tubes stuffed with tyloses.....*Quercus* (White Oak)
12. Water tubes with few or no tyloses.....*Quercus* (Red Oak)
13. Summer-wood with straight, fine tangential lines of zonate metatracheal parenchyma, i. e., parenchyma distinct from small water tubes..... 14
13. Summer-wood with wavy, continuous bands of parenchyma and small water tubes 15
14. Parenchyma lines continuous, distinctly metatracheal.....*Hicoria* (Hickory)
14. Parenchyma lines interrupted and partly paratracheal, i. e., partly associated with or adjacent to small water tubes.....*Fraxinus* (Ash)
15. Tyloses abundant in water tubes.....*Morus* (Mulberry)
15. No tyloses in water tubes .....*Ulmus* (Elm)
16. Wood rays (tangential section) mostly uniseriate..... 17
16. Some or all rays (tangential section) more than uniseriate..... 18
17. Wood rays homogeneous.....*Populus* (Poplar)
17. Wood rays heterogeneous .....*Salix* (Willow)
18. Rays of two distinct widths, 1 to 5 seriate and 15 to 25 seriate, homogeneous .....*Fagus* (Beech)
18. Rays 1 to 8 seriate 19
19. Perforation plates in water tubes scalariform..... 20
19. Perforation plates in water tubes simple..... 22
20. Small water tubes with spirals, rays 1 to 3 seriate (mostly 1 to 2), rays heterogeneous .....*Liquidambar* (Red Gum)
20. Small water tubes without spirals..... 21
21. Rays 1 to 5 seriate and homogeneous.....*Betula* (Birch)
21. Rays 1 to 5 seriate (mostly 2 to 3) and heterogeneous, growth ring ending with a light colored line of wood parenchyma.....*Liriodendron* (Tulip Tree)
22. Parenchyma abundant, terminal, metatracheal, zonate, and uniseriate; rays 1 and 1 to 6 seriate, mostly homogeneous, terminal line of parenchyma prominent .....*Tilia* (Basswood or Linden)
22. Parenchyma sparse, but terminal, paratracheal and metatracheal..... 23
23. Rays 1 to 6 seriate (mostly 3 to 4) and homogeneous to heterogeneous .....*Prunus* (Cherry)
23. (a) Rays 3 to 8 seriate (mostly 5 to 7) and 1 to 3 seriate (mostly 1), mostly homogeneous.....*Acer* (Sugar Maple)
(b) Rays 1 to 5 seriate, with few uniseriate rays, mostly homogeneous.... .....*Acer* (Silver Maple)

SIMPLIFIED METHOD FOR MEASURING DISSOLVED OXYGEN IN STREAMS*

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From the point of view of the biologist, no one factor has more significance than the dissolved oxygen content of the body of water in which aquatic life is being studied. The dissolved oxygen content of such bodies of water is also a factor, indicative of the sanitary condition, to be taken into consideration by health authorities and directors of outdoor activities. The regular Winkler Method and other methods as given in *Standard Methods for the Examination of Water and Sewage* are not suitable for field work and involve laboratory resources and techniques not available to those most interested in stream conditions.

A simple colorimetric method developed by Dr. Issacs and modified by Dr. Gilcreas as reported in the *Sewage Works Journal* in May of 1935 looked particularly promising. It seemed simple, on the face of it, for it took only small variations in the amount of oxygen to change the color of the solution, and these colors accordingly would be easy to match. Dr. Issacs' method employs the use of amidol di-aminophenal hydrochloride.

Samples were taken and tested according to the method and an attempt was made to match them against the standards, as proposed by Issacs and Gilcreas, but they were not of the shade of color and could not be accurately matched. The yellow color appearing in the tests, which caused them to add potassium dichromate to the cobalt chloride to get the necessary shade of color, was totally lacking in the tests made by the writer. This necessitated finding out what was wrong with the tests of this experimental study or the tests made by Issacs and Gilcreas. In testing distilled water for oxygen, an absence of oxygen was expected. It was a surprise to find a yellow color developing which gave the first clue to the origin of the color which Issacs and Gilcreas noted. Since it was known that the distilled water in the laboratory contained a trace of nitrites it occurred to the writer that the yellow of Issacs and Gilcreas's tests arose as impurities in their distilled water, in their chemicals, or in the waters tested. To demonstrate this, nitrogen-free water was used, and it was discovered that by adding traces of sodium nitrite, the yellow color showed up immediately, while amounts of more than two parts per million gave an immediate wine-red color, a condition known to Issacs and Gilcreas.

Consequently by using chemically pure distilled water and analyzed chemicals of reagent grade, a set of standards was made, omitting the yellow-forming potassium dichromate, which would check with our test solutions.

These standards were made by dissolving 238 grams of cobalt chloride in 100 cc. of concentrated hydrochloric acid. Enough water was added to make one liter and when this solution was diluted one half it was seen to match the fourteen parts

* This study is an excerpt from a thesis, Rapid Methods For Health Teachers and Health Educators To Use For Spotting Stream Pollution, developed in the biological laboratories of Illinois State Normal University and submitted in partial fulfillment of the requirement for the degree Master of Science in Education.

per million (p.p.m.) of Standard II which Gilcreas developed in his set of standards. The comparison of the two was made by screening out the yellow of Gilcreas' Standard II. Then twenty cc. of this 14 p.p.m. stock solution was taken as the constant amount of the cobalt chloride solution to be diluted in the making of other standards, expressed in parts per million to be made. Standards were made up for ½ p.p.m. to 14 p.p.m.

The formula used in making these dilutions was:

$$\text{p.p.m.} = 14 \frac{\text{Orig. vol. of standard}}{\text{Final vol.}}$$

$$\text{p.p.m.} = 14 \frac{\text{Orig. vol.}}{X}$$

Key to formula:

p.p.m. = the desired p.p.m. for the standard

14 = the p.p.m. of the solution of cobalt chloride to be diluted

Original volume = a matter of choice and here 20 cc. was used for each standard of the set

X = the final or total volume of the cobalt chloride solution plus the distilled water added

Thus in finding the dilution for the ½ p.p.m. standard the formula becomes:

$$0.5 = 14 \frac{\text{times } 20}{X}$$

$$0.5X = 14 \text{ times } 20$$

$$0.5X = 280$$

X = 560 cc. of water and original solution. Thus 20 cc. of the original solution plus 540 cc. of distilled water will make the total volume of 560 cc. of solution. When this solution is poured into the standard bottle the pink of this solution represents ½ p.p.m., and a sample containing amidol or amidol and citrate if matching this pink can be said to contain ½ p.p.m. of dissolved oxygen.

These color standards were carried into the field and found very convenient for practical use. They were kept in a dark place and no color change was noticed during the period of months they were used.

In making the actual oxygen tests quantities of amidol proportional to those of Issacs were used. Amidol weighing 0.176 grams was put into the 32.5 cc. square glass-stoppered color-standard bottle. Then the potassium citrate solution was made by dissolving 72 grams of citrate in distilled water made up to 100 cc. This citrate solution was taken into the field in a bottle and when the test for dissolved oxygen was made 0.68 cc. of it was pipetted into the bottle containing the amidol and water sample, after which the bottle was stoppered so all the air was excluded. After one half hour this solution was matched against cobalt standard described instead of the Gilcreas and Issacs standards for reasons previously explained.

As mentioned, our first tests did not reveal any interference from small amounts of nitrites, but tests taken when the sewage treatment plant was operating improperly did show such interference. Consequently where interference is indicated, two methods were developed by which the oxygen test could be compared to the standards developed using cobalt chloride. The methods are based on the discovery that nitrites give an immediate color reaction with amidol whereas dissolved oxygen gives a delayed color reaction. One method was developed by which oxygen tests with traces of nitrite present could be tested and the other method for samples containing more than 2 p.p.m. nitrites.

PROCEDURE WITH TRACES OF NITRITE PRESENT

Equipment:

1. Put proper amount of amidol into color-standard bottle I.

2. Put proper amount of amidol into color-standard bottle II.
3. One empty color-standard bottle III.
4. One bottle IV for collecting water sample.

Making the test:

1. Put sample of water to be tested into amidol color-standard bottle I. Add citrate solution and stopper tightly.
2. Collect sample of water tested in water-sample bottle IV.
3. In one half hour fill empty color-standard bottle III with water from water sample bottle IV.
4. At the same time fill amidol color-standard bottle II (no citrate) with water from sample bottle IV, tightly stopper. (Step four is done at the same time as step three.)
5. Immediately match amidol color-standard bottle I (set up one half hour previously) with the cobalt chloride standards. Eliminate the error caused by the yellow color of traces of nitrites by placing amidol color-standard bottle II (showing yellow color produced by traces of nitrites only) in front of the cobalt chloride color-standard bottle being matched; and by placing the color-standard bottle III containing nothing but test water in front of amidol color-standard bottle I. A block comparator may be used for convenience. This modified procedure effectively eliminates errors introduced by the yellow color from traces of nitrites, which gave Issaes and Gilcreas so much concern.

PROCEDURE WITH NITRITES OVER 2 P.P.M.

When more than 2 p.p.m. of nitrites are present the wine-red color which develops immediately is matched against the standards and this reading subtracted from the combined wine-red color of nitrite and dissolved oxygen developing one half hour later.

Under our field conditions, over 2 p.p.m. of nitrites did not occur and there was no necessity for using the second procedure just presented, but it has been given in case such amount might by rare chance be found elsewhere. Both procedures were tested on samples in the laboratory and the procedure involving traces of nitrites was used successfully in the field.

The factors which interfere with the accuracy of this method of testing dissolved oxygen are so few, and the amounts needed to interfere so high, and the elimination of these interfering factors so easy, that the method, in this respect, is well ahead of the standard but lengthy and complex Winkler procedures.

A METHOD OF COLLECTING OXYGEN FROM PHOTOSYNTHESIS

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The author has used the following materials in this method of collecting oxygen from photosynthesis: a glass boiling flask with a capacity of 3 liters; an iron ringstand and rings for supporting the flask; a funnel of suitable size with a stopcock; a two-hole rubber stopper to fit the neck of the flask; a rubber delivery tube provided with a pinchcock clamp and a short piece of glass tubing with a small opening at the end of the tube, and connected with the stopper by a short piece of glass tubing inserted in one hole of the stopper; a 1000-watt electric lamp on a suitable mounting; a glass vial for collecting oxygen; a dish filled with water; a small quantity of potassium bicarbonate; a quantity of Elodea or other suitable water plant.

Procedure.—Prepare 4 liters of a 0.5 percent solution of potassium bicarbonate in distilled water. This is used to supply carbon dioxide to the plants. Support the flask with the ringstand and rings. Put a considerable quantity of the Elodea in the flask, and fill the flask with the bicarbonate solution. Insert the stopper in the neck of the flask, with the stem of the funnel thrust through one hole of the stopper and extending well below the stopper, and the delivery tube connected to the stopper with a short piece of glass tubing which does not extend below the lower surface of the stopper. Fill the funnel with the bicarbonate solution. Put the end of the delivery tube under the surface of the water in the dish. Open the stopcock of the funnel and expel all of the air from the flask and delivery tube with the bicarbonate solution from the funnel. Keep the funnel nearly filled with the bicarbonate solution. Remove the air bubbles from the flask as completely as possible. Then close the delivery tube with the clamp, leaving the stopcock of the funnel open. Place the electric lamp as near the flask as possible without heating the flask and contents.

After considerable gas (mainly oxygen) has collected beneath the stopper in the neck of the flask, invert the vial filled with water over the end of the delivery tube in the water in the dish. Release the clamp and fill the vial with the gas. The gas collected may then be tested for oxygen.

CHEMISTRY

THE RESPONSE OF A THERMOPHILIC FOOD SPOILAGE ORGANISM TO THIAMIN

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The study of bacterial nutrition has advanced greatly in the past few years. It has been known for some time that, when organisms were grown in a simplified medium containing only inorganic salts and glucose, the addition of vegetable extracts, yeast extract, or liver extract greatly stimulated growth. With the isolation and identification of the vitamins, it was found that these definitely defined substances could be added and would replace the extracts formerly used. Thus it was discovered that some microorganisms require vitamins in addition to the inorganic salts, nitrogen containing compounds, and carbohydrates required by all bacteria.

The organism used for this study was a food spoilage organism known as *Clostridium thermosaccharolyticum*. It is important in commercial canning because of its ability to produce resistant spores and cause acid and gas production in non-acid foods. A study of the organism in various media indicated a correlation between growth and acid production. Throughout this work, acid production as determined by titration was used as a measure of the response of this organism to the substance tested.

It has been shown in previous work (1) that this organism needed thiamin, biotin, and para amino benzoic acid when grown in a medium containing hydrolyzed casein as the nitrogen base. Nicotinic acid and pantothenic acid were needed to maintain maximum growth. The omission of thiamin from a medium prepared as described later and designated as the basal medium resulted in a failure of the organism to grow and produce acid. When one microgram of thiamin was added per ten ml. of medium, maximum growth was obtained. The work reported in this paper represents an attempt to determine the least amount of thiamin that would support maximum growth, and to determine the curve of response to varying amounts of thiamin. A basal medium consisting of vitamin-free hydrolyzed casein, dextrose, sodium acetate, adenine, guanine, uracil, inorganic salts and the vitamins: biotin, p amino benzoic acid, nicotinic acid and pantothenic acid was prepared. Thiamin was omitted from this basal medium, since it was the test substance.

In order to determine the response of the organism, tubes of basal medium were prepared, thiamin added in the following amounts: 0, 0.02, 0.04, 0.08, 0.12, 0.24, 0.40, 0.80 and 1.0 micrograms per ten ml. of medium. After inoculation, the tubes were incubated at 55°C. for 72 hours and the acid produced was titrated with N/10 alkali. The results obtained are reported in table 1.

From the figures (Table 1)a curve can be drawn which will represent the response of the test organism to varying amounts of thiamin. Maximum response as measured by acid production was obtained between the values of 0.4 and 0.8 micrograms

TABLE 1.—RESPONSE OF A THERMOPHILIC FOOD SPOILAGE ORGANISM TO VARYING AMOUNTS OF THIAMIN

Medium	Micrograms of thiamin added	Ml of N/10 NaOH required to neutralize		Average
Basal only	0	1.0	1.0	1.0
Basal inoculated	0	1.4	1.4	1.4
Basal inoculated	0.02	2.4	2.6	2.5
Basal inoculated	0.04	3.5	3.4	3.45
Basal inoculated	0.08	4.2	4.2	4.2
Basal inoculated	0.12	5.7	6.0	5.85
Basal inoculated	0.24	7.5	7.5	7.5
Basal inoculated	0.40	8.9	8.8	8.85
Basal inoculated	0.80	8.9	9.2	9.05
Basal inoculated	1.00	9.0	9.2	.1

of thiamin per 10 ml. of medium. Further additions up to 1.0 micrograms gave no greater response than 0.8 micrograms.

There is a regular increase in response in acid production to the amount of thiamin added between 0.02 and 0.4 micrograms per 10 ml. of medium. Between these values we have almost a straight line curve. Organisms responding in this way to vitamins are often used as a means of assaying extracts of food to determine the content of that vitamin to which they respond.

As this organism gave a good curve of response to thiamin, the possibility of using it as a means of determining the thiamin content in an extract of food or other material was tested. Two feed samples were selected for this work. A standard curve was run to obtain the response to amounts of thiamin between 0.02 and 0.4 micrograms. At the same time extracts of the feed were run in the basal medium, all requirements being supplied except the thiamin. When the results were calculated on the gram basis, Sample 1 contained 5.0 to 5.2 micrograms of thiamin and Sample 2 gave 1.5 micrograms per gram. Chemical determinations using the thiochrome method gave the following results: Sample 1—3.7 micrograms, Sample 2—0.7 micrograms per gram. Thus, the microbiological method gave much higher results than the chemical method, in Sample 2 more than twice as much.

Further tests were conducted in an attempt to determine the reason for the difference in results between the two methods. Previous work (1) had shown this organism responded to the thiazole portion of thiamin when it was added to a medium containing no thiamin. The organism did not respond to the pyrimidine fraction tested. This pyrimidine had an ether linkage in the fifth position of the pyrimidine ring. Schultz, Atkin and Frey (2) have shown, that for yeasts, thiamin treated with sulfite loses 98 percent of its activity for these microorganisms. By this treatment thiamin is broken down into a thiazole fraction and a sulfonic acid pyrimidine. It was assumed that if the feed samples could be treated with sulfite and the activity destroyed, other stimulating substances in the feed could be determined and thus make it possible to include them in the basal medium and thus obtain closer checks between the chemical and microbiological method of determining thiamin. On the basis of

this assumption, extracts of the feed were treated with sulfite according to the method of Schultz, Atkin and Frey. Varying quantities of the treated extract were added to the basal medium. The results obtained after this treatment were identical with those previously reported for the untreated extracts. This seemed to indicate that the organism was able to resynthesize thiamin from the two fractions produced by sulfite cleavage and use it. To test the correctness of this conclusion thiamin itself was treated with sulfite and added to the basal medium in varying amounts. The organism responded to this sulfite treated thiamin in the same way as to the untreated thiamin. Thus it appears that sulfite treatment does not destroy thiamin activity for this thermophilic spoilage organism as it does for yeast. It is possible that pyrimidine structures similar to the above and other types may be encountered in extracts of feeds. If certain thiazole fractions are present the organism will then react as though thiamin were present, since it has the ability to synthesize thiamin from these fractions. The thiochrome method is more or less specific for thiamin and thus would not measure these fractions. This may be one of the reasons why higher results were obtained with this microbiological method than with thiochrome method. There are probably other factors which affect this determination but they were not investigated.

CONCLUSIONS

The food spoilage organism *Clostridium thermosaccharolyticum* responds quantitatively to thiamin in the range of 0.02 to 0.4 micrograms. From this response a standard assay curve can be drawn.

The results of assays of two feeds gave results higher than those obtained by the thiochrome method.

Sulfite treatment of thiamin and of extracts of feeds does not destroy the activity of thiamin for this organism.

REFERENCES

1. Clark, F. M. and Mitchell, Winifred R. 1944. Studies on the Nutritional requirements of *Clostridium thermosaccharolyticum*. Arch. of Biochem. Vol. 3, p. 459-466.

2. Schultz, A. S., Atkin, Lawrence and Frey, C. N. 1942. Determination of Vitamin B_1 by yeast fermentation method. Industrial and Eng. Chem. Vol. 14, p. 35-39.

ZINC AND MAGNESIUM COBALTINITRITES FOR QUALITATIVE DETECTION OF POTASSIUM

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The methods for qualitative detection of sodium and potassium ions are not too satisfactory, owing to the solubility of the salts in question. The most delicate tests for these ions seem to be the use of sodium hexanitritocobaltate for potassium and of zinc or magnesium uranyl acetate for sodium[1]. If these reagents are used, however, a separate portion must be used for each test because of the introduction of sodium ions in testing for potassium. Furthermore, if potassium is present, it must be at least partially removed before testing for sodium on account of the similar solubilities of the potassium and sodium salts formed with either zinc or magnesium uranyl acetate.

It seemed desirable to develop a reagent for the detection of potassium which would retain the sensitivity of sodium cobaltinitrite, but which would not introduce the sodium ion and would leave the solution in the best form for the detection of the sodium ion. The use of zinc or magnesium uranyl acetates for the detection of sodium suggested the use of zinc or magnesium cobaltinitrite.

Previous work indicated that such compounds could be formed, because unstable solutions containing cobaltinitrite are formed when the gas from the action of concentrated nitric acid on metallic copper is passed through a mixture of the acetates of cobalt and either zinc or magnesium[2]. When such solutions were treated with the gas formed by the action of dilute sulfuric acid on sodium nitrite, the amount of cobaltinitrite varied greatly and for no apparent reason[3].

EXPERIMENTAL

A solution was made up which was one molar in zinc acetate and two thirds molar in cobalt acetate. Because of the lack of uniformity of the gas resulting from the reduction of nitric acid by copper, nitrogen dioxide was prepared by the action of nitric acid on sodium nitrite. The gas thus formed was passed through the mixture of acetates. Calculations indicated that 0.47 mols or 32.43 grams of sodium nitrite would be required to form enough nitrogen dioxide to convert the cobalt in 100 milliliters of this solution entirely to cobaltinitrite.

One hundred milliliters of the mixed acetates was placed in a gas wash bottle, over glass beads, and the nitrogen dioxide was then bubbled through the solution. Different amounts of sodium nitrite were used, varying from 0.47 mols to four times that amount. As the amount of sodium nitrite used was increased, the amount of cobaltinitrite formed increased fairly regularly until 3.75 times the calculated amount was used, and then fell off sharply with four times the amount of nitrite. In all cases, much of the gas seemed to pass through the solution without being absorbed. In all cases, twenty milliliters of the resulting solution was diluted to 100 milliliters, precipitated by the addition of an excess of potassium chloride solution, filtered, washed and dried at 110° C. If the precipitate was filtered off within an hour of precipitation, more precipitate formed in the filtrate. When several samples were precipitated at the same time and allowed to stand for differing lengths of time before filtration, the precipitate usually, but not always, increased very distinctly in amount with length of time of standing in the mother

[1] Kolthoff, I. M., *Z anal Chem.*, *70*, 397 (1927).
[2] Adams, Hall and Bailey, Ind. Eng. Chem., Anal. Ed., 7, 310 (1935).
[3] Lippincott, Ann, Unpublished work, 1945, MacMurray College.

TABLE 1

Wt. $NaNO_2$	Mols $NaNO_2$	Weight of potassium precipitate
32.43	0.47	0.0693, 0.0860
48.64	(1.5) (0.47)	0.4151, 0.4117
81.08	(2.5) (0.47)	1.0482, 1.2093, 1.3241, 1.3239
113.50	(3.5) (0.47)	1.1035, 0.9857, 0.9813, 1.2268 1.3094, 1.2795, 1.5782
121.60	(3.75) (0.47)	1.2331, 1.4630, 1.4409, 1.5727
129.72	(4.0) (0.47)	0.1570, 0.1580

liquid, up to sixty hours. In a number of instances the precipitate became dark on heating, and in one case, nitrogen dioxide was observed coming from the drying precipitate. If in the formation of the complex, all the cobalt had been changed to cobaltinitrite, the precipitates from these twenty milliliter portions should have weighed 6.03 grams, assuming the precipitate to be $K_3Co(NO_2)_6$. The largest amount actually secured was 1.58 grams. The results are summarized in Table I.

For the determination of the composition of the precipitate formed with potassium chloride, one hundred milliliters of the mixed acetates of cobalt and zinc was treated with the gas made by adding nitric acid to 121.6 grams of sodium nitrite. Excess of potassium chloride solution was then added and the mixture allowed to stand over night. It was then filtered, washed, and dried at 110° C. Samples were analyzed electrolytically for cobalt[4], showing 13.94 percent and for potassium as the perchlorate[5], showing 23.44 percent, an atomic ratio of 2.53. Qualitative tests for zinc were negative. The percentages of cobalt and potassium in $K_3Co(NO_2)_6$ are 13.01 and 25.93 respectively.

In the same way, a cobaltinitrite was prepared by the action of nitrogen dioxide on a mixture of cobalt and magnesium acetates. This was precipitated with potassium chloride and the resulting precipitate was analyzed as above for both potassium and cobalt. The precipitate was 23.26% potassium and 13.39% cobalt. Qualitative tests for magnesium were negative. The atomic ratio found was 2.62.

To compare the stability of the two solutions, 200 milliliters of solutions which were two thirds molar in cobalt acetate and molar in either zinc or magnesium acetates were treated with the gas secured from 170 grams of sodium nitrite. This proportion of nitrite was somewhat less than that previously found to yield the greatest amount of complex, as it was desired to avoid the effect of decomposition caused by too great an amount of gas. The complex was formed in both cases; almost twice as much was formed in the magnesium solution as in the zinc solution, but still less than a third of what would have resulted had all the cobalt been converted to the nitrite complex. The solutions were kept in bottles covered with watch glasses to allow NO_2 to escape, and analyzed daily. Although the magnesium solution was more concentrated at first, neither showed any sign of cobaltinitrite after five days although both gave slight but distinct precipitates with potassium chloride after four days. A solution of sodium cobaltinitrite was found under the same conditions to give an immediate precipitate with potassium chloride after two weeks.

CONCLUSIONS

1. Cobaltinitrite is formed by passing oxides of nitrogen through a mixture of acetates of cobalt and either zinc or magnesium. The most uniform results are obtained when the gas is secured from the action of nitric acid on sodium nitrite. A sufficiently great amount of gas results in a decrease in the yield.

[4] Scott, *Standard Methods of Chemical Analysis*, N. H. Furman, editor, p. 312, Fifth edition, D. Van Nostrand Co.
[5] *Idem*, p. 870.

2. Analysis of the potassium precipitate does not conform closely to what seem to be the most likely compositions, but $K_3Co(NO_2)_6$ seems the most probable.

3. The magnesium salt seems to be more readily formed than the zinc salt but is not appreciably more stable.

4. Solutions of cobaltinitrite made by passing oxides of nitrogen through mixtures of cobalt actetate with either zinc or magnesium acetates are distinctly less stable than that made by adding acetic acid to a mixture of sodium nitrite and cobalt acetate.

p-DIMETHYLAMINOAZOBENZENE-p-SULFONAMIDE

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In the course of an investigation the compound p-dimenthylaminoazobenzene-p-sulfonamide was prepared and it was decided to study some of its properties. Its close similarity to methyl orange suggested its possible use as an indicator. The structure of the two compounds is identical except for the amide group replacing the OH group found in methyl orange.

Examination of the literature reveals that p-dimethylaminoazobenzene-p-sulfonamide was prepared in Russia in 1938[1]. The investigators prepared a number of azo compounds by the same general method here used, but they were interested primarily in the therapeutic values of the compounds. The common physical properties were not included in their report.

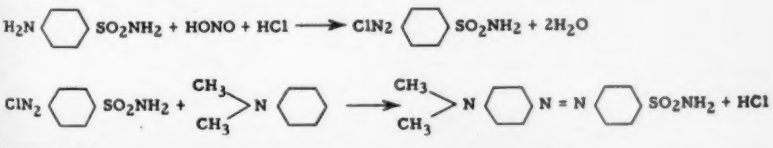
EXPERIMENTAL

17.2 gm. of p-aminobenzenesulfonamide are dissolved in 150 ml. of water containing 25 ml. of concentrated HCl; 12.6 gm. of dimethyl aniline are dissolved in 20 ml. of concentrated HCl and the solution diluted with about 200 ml. of water; 6.9 gm. of $NaNO_2$ are dissolved in about 15 ml. of water. The three solutions are then cooled in an ice-water mixture. The solution of $NaNO_2$ is added to the p-aminobenzenesulfonamide and thoroughly stirred. The resulting diazonium salt is then slowly poured into the dimethylaniline, stirring constantly. The solution first becomes orange and gradually changes to a deep red. Crystals appear in about ten minutes. The solution is further stirred for about ten to fifteen minutes and allowed to stand for an hour. The precipitate is filtered with suction and washed with water. The yield is almost quantitative.

The crystals are small, well defined and purplish-red in color. The compound is practically insoluble in water, benzene, and ether; somewhat soluble in acetone, methyl and ethyl alcohols; and still more soluble in ethylene glycol. Upon heating, the compound decomposes at about 188 to 195° C. before melting.

An approximate determination of the pH at which the dye changes color showed the range to be about between a pH of 3 and 4.5. A series of buffer solutions was made between a pH of 3 and 4.6 in steps of 0.2 of a pH unit using the directions of Clark and Lubs and mixing the proper amounts of 0.1 M $KHC_8H_4O_4$ and 0.1 N HCl and 0.1 N NaOH. The pH values of these buffers were then measured electrometrically using a glass and calomel electrode, and the differences between the calculated and measured values were only 0.01 to 0.02 of a unit.

After trial with numerous solvents, a 0.1 percent solution of the dye in ethylene glycol was made and used; 0.15 ml. of this solution were added to 10 ml. of each buffer and the colors were observed and compared with those produced using methyl orange as an indicator. The pH intervals for the two indicators were found to be almost identical; 3.2 to 4.2 for methyl orange, and 3.0 to 4.2 for the sulfonamide. The



[1] L. N. Goldyrev and I. Ya Postooskii, J. Applied Chem. (USSR) *11*, 316-27, (1938).

point of greatest change for methyl orange seemed to occur between a pH of 3.4 and 3.6 while that for the sulfonamide was about 0.2 of a unit higher, 3.6 to 3.8.

The sulfonamide as used in the above tests tended to precipitate when added to the buffer solutions, and the colors produced were not as deep as those obtained using methyl orange. The color change offered one advantage, however; it was from red to yellow with practically no orange in between.

The color intensity obtained with methyl orange is due to the fact that it is a water-soluble sodium salt of a weak acid, whose behavior in acid and basic solutions is well postulated. The water insolubility of the sulfonamide and the presence of the amide group instead of the acid OH group may explain the faint colors produced, but the nature of the compound also presents a mechanism in acid and basic solutions which is not clear. It seems that the introduction of another sulfonic group might overcome this difficulty. This, of course, may change the indicator interval and also its colors, and this possibility may be investigated in the future.

SOME FACTORS IN THE SYNTHESIS OF 3, 5-DINITROBENZOTRIFLUORIDE*

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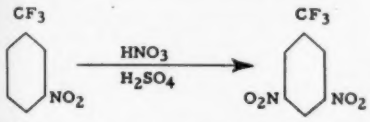
The synthesis of certain symmetrical aromatic fluorine compounds under investigation in this laboratory necessitated the development of a large-scale laboratory preparation of 3, 5-dinitrobenzotrifluoride.



Adaptation of the original synthesis by Finger and Reed[1] of this dinitro compound to a large-scale laboratory preparation required further investigation to determine optimum yield conditions.

The synthesis of 3, 5-dinitrobenzotrifluoride involves the nitration of *m*-nitrobenzotrifluoride with a fuming nitric and sulfuric acid mixture. The nitro group entering the aromatic nucleus is directed to the meta position common to both the $-CF_3$ group and the original nitro group. The difficulty involved in nitrating *m*-dinitrobenzotrifluoride may be predicted when a comparison is made with *m*-nitrobenzene, as both compounds contain two meta directing groups in the 1,3 positions. The nitration of *m*-dinitrobenzene is extremely difficult; therefore, it would be expected that nitration of *m*-nitrobenzotrifluoride would also be difficult. This theoretical analogy was verified experimentally as it was necessary to use a fuming nitric-sulfuric acid mixture at a temperature of about 100°C. in order to obtain a satisfactory yield of 3,5-dinitrobenzotrifluoride.

To develop a standard procedure for a large-scale laboratory preparation of 3,5-dinitrobenzotrifluoride which would produce a maximum yield of product, consistent with economical use of both time and materials, required a study of the effects on the dinitro yield by the following conditions: (1) concentration and volume of sulfuric and nitric acid used in nitration; and (2) time and temperature of nitration.

An investigation of the effects of the conditions given above on the yield of 3,5-dinitrobenzotrifluoride was conducted by performing a series of nitrations in which the conditions were varied from run to run. The yield of dinitrobenzotrifluoride as affected by various concentrations and volumes of acids used are shown in Tables 1 and 2.

From the data obtained, indications are that fuming sulfuric acid (30 percent free SO_3) and fuming nitric acid (sp. gr. 1.49-1.5), a nitration temperature of 100°C., and a heating period of three hours produced better yields of 3,5-dinitrobenzotrifluoride. Nitration temperatures higher than 100°C., and heating periods longer than 3 hours were found to effect only negligible increases in the yield.

The crude 3,5-dinitrobenzotrifluoride, washed free of acid with dilute alkali, is still contaminated with small amounts of isomers and unreacted *m*-nitrobenzotrifluoride which make imperative an efficient purification process. Fractional crystallization of the crude product from methanol gave a pure product but

* Published with the approval of the Chief, Illinois State Geological Survey.

TABLE 1.—YIELDS OF 3,5-DINITROBENZOTRIFLUORIDE AS AFFECTED BY DIFFERENT ACID CONCENTRATIONS

Reagent	Concentration	Average Yield of 3, 5-Dinitrobenzotrifluoride
Fuming H_2SO_4	15% SO_3	35 Percent
Fuming H_2SO_4	25% SO_3	40 Percent
Fuming H_2SO_4	30% SO_3	45 Percent*
Fuming H_2SO_4	60% SO_3	40 Percent
Fuming HNO_3	Sp. gr. 1.49-5	45 Percent*
Red fuming HNO_3	.....	40 Percent

* Procedure was standardized on these concentrations.

TABLE 2.—YIELD OF 3,5-DINITROBENZOTRIFLUORIDE VS. VOLUME OF REAGENTS

Acid	Volume Ratio Acid: C_6H_4 (CF_3) (NO_2) 1, 3	Percent Yield of C_6H_3 (CF_3) $(NO_2)_2$ 1, 3, 5
H_2SO_4 (30% free SO_3)	5:1	41
H_2SO_4 (30% free SO_3)	3.6:1*	45
HNO_3 (Sp. gr. 1.99-1.5)	1.8:1	41
HNO_3 (Sp. gr. 1.49-1.5)	6.4:1*	51

* Procedure standardized on these ratios.

low recovery, due to the additional solubility effect of the unreacted *m*-nitrobenzotrifluoride. Purification by steam distillation was found to be impractical because the dinitro compound is slightly steam distillable. Fractional distillation under diminished pressure followed by recrystallization of the dinitro from methanol proved to be the most efficient method for purifying the crude dinitro product.

EXPERIMENTAL

Nitrations were carried out in a 5-liter three-necked (standard joints) round-bottomed flask submerged in a water bath containing a coil of copper tubing with connections so arranged as to permit circulation through the coil of either low or high pressure steam, tap water, or a cold brine solution. The flask was equipped with a Claisen adapter to which was attached a dropping funnel and a reflux condenser, a thermometer, and a mercury-sealed stirrer coupled to the shaft of a one-half h.p. motor.

m-Nitrobenzotrifluoride was added to the stirred fuming nitric and sulfuric acid mixture maintaining the nitration temperature at 100° C. throughout the addition and the subsequent two-hour heating period. The efficient heat transfer system previously described makes possible precise temperature control at 100° C. of the nitration reaction which is exothermic.

A modification of the above experimental procedure involves a nitration of benzotrifluoride with the spent acid to produce enough *m*-nitrobenzotrifluoride for a subsequent large-scale dinitrobenzotrifluoride preparation. This modification is advantageous from the standpoint of more efficient utilization of materials but has the disadvantage of increasing the dinitro production time.

SUMMARY

A study was made of the nitration of *m*-nitrobenzotrifluoride to determine the conditions most favorable for obtaining good yields of 3,5-dinitrobenzotrifluoride. From the results thus obtained, a large-scale laboratory method of preparation of 3, 5-dinitrobenzotrifluoride was developed.

BIBLIOGRAPHY

1. FINGER AND REED. J. Am. Chem. Soc. *66*, 1972-1974 (1944).

GEOGRAPHY

A CROSS-SECTION OF THE CENTRAL DIVISION OF ILLINOIS

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The Central Division of Illinois is that portion of the state which lies between an east-west line from the Mississippi below the mouth of the Rock River to the great bend of the Illinois River to the state of Indiana, and an east-west line from the Mississippi at the mouth of the Illinois River to the Shelbyville moraine to the Indiana state line. This area, which is dominantly agricultural, contains the best grain lands in the state as well as some of the best land of the entire region known as the corn belt, of which this district and other parts of the state are a part.

Approximately at the center of the division is the largest city of the state which can be thought of as indigenous rather than a regional or extra regional center. At fairly regular intervals of about 50 miles are other indigenous centers with populations of less than 100,000. Transportation patterns radiate from each in all directions through the evenly spaced villages tying the entire division into one large agrarian web.

Three districts, the Eastern, Southwestern, and Western, constitute the major segmentation of the division, each of which consists of several sections; The Grand prairie, the Kankakee lowland, the Upper Illinois valley, and the Middle Illinois valley are the sections of the Eastern District; the Sangamon plain and the Lower Illinois valley are the sections of the Southwestern District; whereas the Galesburg prairie, the Upland forest, and the Mississippi border (central segment) are the sections of the Western district. The Shelbyville moraine, and the Illinois and Mississippi valleys form the limits of the districts. The predominance of physical nomenclature is obvious and indicates the undesirability or difficulty of using cultural delimitations in an area of as complete and homogeneous occupance as that of the Central Division of Illinois. Thus, the quality of occupance and the desirability or lack thereof of the above areal patterns might become apparent by means of an east-west cross-section through the division.

Innumerable traverse lines could be run, each of which would demonstrate its own individuality as well as revealing the general quality of the district. The line selected follows highway Illinois 10 from the state line through Danville, Champaign-Urbana, to Clinton; U. S. 54 through Springfield to Jacksonville; and state route 104 to Quincy on the Mississippi. The first 80 miles crosses the Eastern District, the next 105 miles the Southwestern, and the last 50 the Western.

EASTERN DISTRICT

Vermilion, Champaign, Piatt, and DeWitt counties are crossed in the first segment of the traverse, the Grand prairie section. Because the traverse crosses the southern portion of the Eastern District, only the Grand prairie section is included. This is the Cash Grain type of farming area (as expressed by Case and

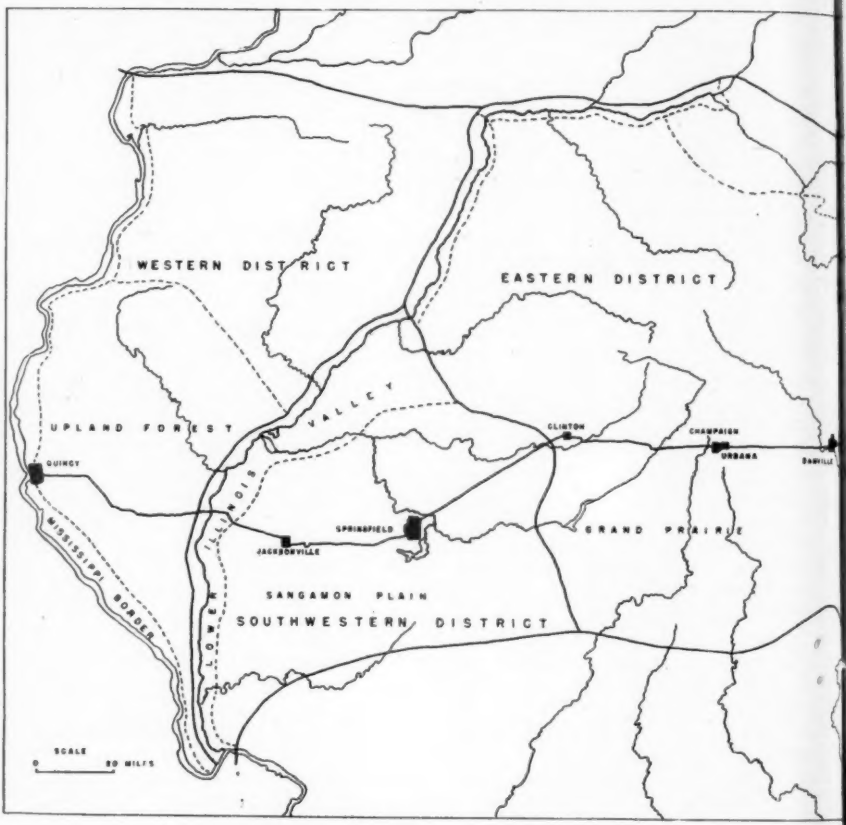

FIG. 1.—The Central Division of Illinois.

Meyers) which is associated with the prairie area of most recent glaciation—the area within the Shelbyville moraine. Farms here are large, ranging in size, according to the last census, from averages of 154 acres in Vermilion county to 210 in Piatt. As far as the eye can see, the cultivated fields of corn and small grains extend over the gently rolling surface of the deep black prairie soil. From Danville to Clinton the only natural interruption to the repetitious pattern of tilled fields and well-spaced farmsteads is the wooded valley of the streams which flow outward from the approximate center of the Grand prairie. At Danville, the old strip mines and the valley of Middle Fork, the valley of Salt Fork at St. Joseph, the Sangamon valley near Lodge and the valley of Salt Creek near Clinton afford the major interruptions. That this is a wealthy area of commercial grain farming is apparent on all sides. Well-built farm houses, many of them of the square hip roofed

variety designed several decades ago to fit the continuousness of the prairie; a large barn (small, however, in comparison with those of the dairy zones) many of which are red in color; a king-size corn crib; and an enclosing border of trees reappear at regular intervals. Motorized equipment of all varieties is in evidence everywhere, monuments to the high standard of rural living, the ever-enlarging farm, the declining rural population, increasing farm mortgages and farm tenancy. It must be kept in mind that it requires rich land to support large mortgages and two families—the owner and tenant. With the exception of hogs and a few dairy cows on each farm, animals are notable by their absence. Champaign and Piatt counties have the highest crop values per acre on the entire traverse, whereas livestock values are lowest, being approximately one-quarter of the crops. Dairy values are insignificant.

Three of the four county seats (including Champaign and Urbana as a unit for general discussion only), and incidentally the largest urban centers in the four counties crossed, lie on the route of this traverse. Despite the inclusion of such incongruous features as coal mines and the state university, the largest urban centers are examples of major service centers of a productive agrarian countryside. Stripped to the absolute essentials are the little villages, each a prototype of the cash grain producing Grand prairie village. Each village possesses at least one grain elevator and cobb burner (a sign of waste or perhaps the extensive type of occupance of this portion of the country,) a stack of grain doors for railway box cars, innumerable bins of the ever normal granary of prewar depression days, and insignificant or lacking facilities for handling livestock. Aside from the usual stores, farm implements, and automotive supplies point steadily at a community interest of extensive, mechanized, commercial grain farming—the present occupance of the fertile Grand prairie.

SOUTHWESTERN DISTRICT

Crossing the Shelbyville moraine beyond Clinton (the moraine is here an inconspicuous feature of the landscape), the traverse continues for another 105 miles through Springfield and Jacksonville to the village of Chambersburg near the west bluffs of the lower Illinois Valley. This segment of the traverse, which crosses Logan, Sangamon, and Morgan counties passes through the Southwestern district which consists of two sections, the Sangamon plain and the Lower Illinois valley.

Although this district, like its neighbor to the east, is an important farming area with from 85-95 per cent of the total area in farms which range in average size from 158 to 191 acres, a distinctive personality prevails which clearly sets the district out. This area lies within both the Cash Grain and General Farming (*Types of Farming* by Case and Meyers). The eastern portion of the traverse, the 45 miles from Clinton to Springfield, passes through the Cash Grain area. There the farms are about as large and production per acre is about as high as it is in the Grand prairie. Despite the fact, however, that the village of Cornland is encountered half way between the old county seat of Mount Pulaski and Springfield, small grains, especially wheat, is much more important as well as pasture and livestock. In fact, live stock values have risen from one-quarter to one-third of the grain values per acre.

Beyond Springfield the average size of the farm decreases, the farmsteads appear to be much older than those on the Grand prairie, house types similar to those found in Ohio (there locally known as a Pennsylvania house) appear, and everywhere except in the wide alluvial trough of the Illinois River, livestock is more numerous. The value of total production per acre has fallen but live stock values have risen to about 50 per cent of the value of crops. As on the Grand prairie, dairying is unimportant except as a local service to the towns and villages. Forests are more numerous in this district, the entire western portion was originally forested as well as the Sangamon bottoms in this portion, and the black prairie soil of the recent Wisconsin drift has given way to the browns and yellows of the forest soil on the older Illinoian till, with here and there evidence of loess deposits. As in the Danville area of the Grand prairie, coal mines, here shaft mines, add an incongruous note to the agrarian scene.

Although dominantly agricultural, the political function (with its historical tradition as well as its agrarian service center nature) of Springfield leaves its stamp upon its locale—the Sangamon plain. Situated just east of the center of the Sangamon plain the State capitol is the focal point of one of the best developed radials of highways and railroads in the state.

In contrast to the rolling surfaces of the Sangamon plain is the funnel shape Lower Illinois valley; a great alluvial trough about 150 feet lower than the upland and eight miles wide at the point where the traverse crosses the valley. It is several times this width at the upper end and about half as wide where it approaches the Mississippi. Dikes and drainage ditches and unused wet alluvial land are ample evidence of the flooding of the inner valley, whereas the roads, villages, farmsteads, and tilled fields occupy the well-drained alluvium of the slightly higher terraces. The highway from Meredosia (Marais d'osiers, the basket reed swamp) to Chambersburg crosses the inner valley and the river on an extremely high bridge.

THE WESTERN DISTRICT

From the west bluff of the Illinois valley above Chambersburg the traverse extends for 50 miles across the Western District to Quincy on the Mississippi River through Pike and Adams counties. Although this is an area of general farming, the farms are smaller here than in either of the other two districts and the returns are lowest, being only two-thirds of the per acre returns on the Grand prairie. Likewise, the returns from livestock have risen until it is almost as great as the returns from crops.

The first of the two sections of the Western District to be encountered and the one over which most of the traverse extends is the Upland Forest. Stream erosion to an extent of about 100 feet by the minor tributaries of both the Illinois and Mississippi have turned both the eastern and western facing slopes into rolling terrain separated by a flat undissected upland. Originally forested, much of the area is still in timber with extensive areas of apparently recently abandoned crop land (probably taken out of cultivation in the early days of A. A. A. crop control program) in brush, and thicket. Brown forest soil is in evidence in the cultivated fields with thick mantles of loess sharply exposed on west facing slopes.

The highway wanders up the Illinois tributary slope across the flat

divide and over into area dissected by the Mississippi tributaries through such widely spaced little villages as Fishhook, Fairweather, and Liberty. The widely spaced railroad pattern in this portion of the district gives the impression of isolation to the villages not served by them.

At the end of the traverse is Quincy, occupying that point on the upland that most closely approaches the Mississippi. The alluvial lands of the Mississippi border are very narrow there although they widen to segments ten miles or more in width above and below the city. Both the highway and railroad bridges cross the river here at one of its narrowest points. Most of the rejuvenated industries as well as the railroad occupy the narrow flood-plain where once the activities of a thriving river town were centered, whereas the city itself is spread out upon the upland.

Thus terminates a traverse designed to highlight a cross-section of five sections of the three districts of the Central Division of Illinois.

GEOLOGY

REFLECTIONS ON RECENT DIAMOND-DRILL EXPLORATION IN THE ILLINIOS COAL FIELD*

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Diamond-drilling to obtain cores of the rock penetrated has long been the most approved method for coal bed exploration. It is obvious why this is so.

Coal mining and exploration companies drilled many hundreds of diamond-drill holes in the Illinois coal fields before 1915. When these holes were being drilled, either the present State Geological Survey was not yet in existence, or it was a new organization and the exploration agencies were reticent in allowing representatives of the Survey access to the cores and to the highly confidential information that these contained. In these early years the Survey occasionally added cores to its collections, particularly from one exploration company that drilled many holes in southern Illinois between 1912 and 1915, and was able to examine others in the field. However, most of the information about this early drilling came to the Survey files some time after the holes were drilled, usually in the form of generalized and commonly unsatisfactory driller's logs. One of these early cores provided the basis for the type succession of the McLeansboro formation[1]. Another was the core of the deep hole at New Haven, White County, which extended through the Pennsylvanian beds from about the position of the New Haven ("Shoal Creek") limestone.[2]

The number of cores actually logged by the Survey was only a small percentage of those drilled. Even as late as 1920 the Survey had not had access to cores of any holes drilled in Franklin County.

Between 1915 and 1940, deep core-drilling in the State was infrequent, except for a considerable number of holes drilled by the Madison Coal Corporation in Sangamon, Madison, and Williamson counties between 1920 and about 1925. The records of this drilling, such as it was, have largely come to the Survey files, and the cores of most of the holes drilled by the Madison Coal Corporation were examined by members of the Survey staff some time after the holes were drilled. Some of the cores representing the deeper holes were obtained for the Survey collection.

Mining operations in Illinois by 1940 had gone far toward exhausting the supply of coal explored in previous years. The increased productivity of the war years forced the exploration of new areas in the anticipation of the approaching need for new supplies of coal upon which to maintain the industry. Furthermore, although certain areas not yet exploited had been drilled, the records of such drilling were seen to be unsatisfactory for evaluating the coal resources and the quality of the coal and for planning mining opera-

* Presented with the permission of M. M. Leighton, Chief, Illinois State Geological Survey.
[1] Udden, J. A., Delafield drill core: Illinois Geol. Survey Bull. 4, p. 203, 1907.
[2] Cady, G. H., Coal resources of District V: Illinois Geol. Survey Coop. Mining Ser. Bull. 19, p. 18, 1919.

tions. Accordingly redrilling of such areas was often regarded as necessary. As a result, the last three years have seen a noteworthy revival of exploratory diamond-drilling in the southern half of the State, an activity which is probably not at an end.

The recent drilling has been in Bond, Madison, Randolph, Christian, Fayette, Franklin, Jefferson, Saline and Williamson counties. In the central-eastern part of the State there has been considerable exploration in Douglas County. With most of this drilling the Survey through the Coal Division has been in close touch, actually being on the ground when hundreds of feet of the cores were pulled. In addition we have had opportunity to log numerous cores of holes located adjacent to the east boundary of Illinois in Vigo and Sullivan counties in western Indiana. Altogether, some 45 to 50 thousand feet of cores have been logged by members of the Coal Division in the last three years.

This increase in detailed information concerning the Pennsylvanian succession has been mainly with respect to the McLeansboro and the upper part of the Carbondale groups down to and including Harrisburg (No. 5) coal bed. However, additional information has been obtained from several drill-holes in Franklin County, from one in Madison County, from two in Lawrence County, and from several in Vigo County, Indiana, regarding strata lying near or below the base of the Carbondale group.

The examination of these cores has provided a detailed picture of the stratigraphic succession for several areas, from a position that appears to represent the Curlew limestone of the upper Tradewater group to a position somewhat above that of the Millersville limestone of the upper part of the McLeansboro group. In Fayette County, a core has been logged from a short distance above the Millersville limestone (which is exposed in outcrop in the immediate region) to the No. 6 coal bed. In Jefferson County the cores logged extended from about 300 feet above what is called the "Shoal Creek" limestone in that county to below the position of the Harrisburg (No. 5) coal bed. In Franklin County the drilled section extends from above the "Shoal Creek" limestone to the upper part of the Tradewater group down to a short distance below what is believed to be the Curlew limestone. In Madison County the explored section extends from a short distance above the Carlinville (possibly the same as the Shoal Creek) limestone to the La Salle (No. 2) coal bed. In Vigo County, Indiana, the strata explored extend from what is thought to represent the Shoal Creek limestone to Indiana No. III coal bed. In Lawrence County drilling started in the Pennsylvanian beds some 200 to 250 feet above the "Shoal Creek" limestone and continued to the coal bed that probably represents the No. III coal bed of Indiana.

The study of these diamond-drill cores and the information provided by the field and laboratory work in connection with the logging of rotary drill-holes suggest a few more or less significant generalizations and raises certain problems in regard to Pennsylvanian sedimentation and succession in the Illinois coal field.

1) The "Shoal Creek" limestone seems to be one of the most widespread limestone members of the Pennsylvanian strata within the area bounded by its outcrop. Its similarity from hole to hole in Franklin and Jefferson counties is remarkable, as is likewise the simi-

larity of the limestone in the cores with the limestone outcropping in the northern part of Washington County, northwest of Nashville. However, there are places in the central part of the Illinois Basin where, if present, it is not readily recognized.

2) The Herrin limestone or caprock of No. 6 coal bed is probably the most widespread Pennsylvanian limestone in Illinois. It is also notably uniform in character, but in southwestern Illinois it takes on nodular structure not generally found elsewhere. But this limestone is not absolutely continuous, as witness its common absence above the Grape Creek coal bed in Vermilion County, above the "Second Vein" in La Salle County, and in places in the thick coal area in Franklin County.

3) All other limestones appear to have a fringe-like distribution with respect to the border of the depositional area. The Cutler and Bankston limestones fringe the southwestern edge of the coal basin; the Lonsdale limestone fringes the western and northern and possibly also the eastern margins as the West Franklin limestone.

4) Recent drilling has not yet produced final answers to the problems of the relation of the Carlinville and Shoal Creek limestones, of the Millersville, the La Salle, and one or more limestones designated as Livingston and Shaw Point, of the Greenup and Omega limestones. Although the position of the Scottville limestone is definitely established as being between the Piasa and Carlinville in Macoupin county, none of the drilling in Madison, Bond, and Christian counties has penetrated a limestone at the position appropriate for the Scottville. It also appears to be one of the "fringe" limestones mentioned above.

It is probable that certain of the higher limestones of the McLeansboro also have restricted "fringe" distribution. This appears to be the case for the La Salle, Shaw Point, Millersville, Omega, and Greenup, and possibly the limestone or limestones designated as the Livingston. In general, core drilling has not been so distributed as to penetrate the horizon of those higher limestones, and much uncertainty continues to exist about their relationships.

5) Marine limestones are by no means always underlain by coal beds. Limestones with which coal beds are commonly associated are the St. David (No. 5 coal bed), Herrin (No. 6 coal bed), Cutler (Cutler coal bed), and there are a number of others that are less well known. On the other hand, marine limestones with coal beds but a short distance above them are the Stonefort, Herrin, Bankston Fork, and West Franklin; and others less well known.

6) Special attention has been paid to the character of the strata intervening between fairly widely spaced coal beds. This is the position in which erosion disconformities are most commonly found. However, it seems to the writer that the arrangement and relationship of beds just as often and, indeed more commonly except at certain positions, are indicative of complete transition in deposition from one coal bed to the next. The transitional succession most commonly and characteristically proceeds downward from the nodular-bearing greenish-gray massive clay-shale beneath the underclay of the coal bed to a greenish-gray clay shale also usually massive, containing frequent sideritic or calcareous veinlets, granules, or spongy masses of siderite or calcite or both. This in turn grades down into a greenish-gray shale at first faintly

and then more strongly interlaminated with light gray or nearly white siltstone. The amount of siltstone commonly increases downward and the interbedded or interlaminated shale and siltstone is likely to display ripple-marked, slumping, and marbleoid pattern. The shale also changes color from greenish-gray to gray. These beds may grade on the one hand into gray massive, micaceous coarse siltstone which gradually become finer and finer, more fossiliferous, and more calcareous as the next coal bed is approached, or the transition may be to more sandy beds. Usually the change from these sandy beds to the underlying fine shale above the next coal bed is rather sharp, but evidences of erosion and basal conglomerates are the exception rather than the rule. In the drill-cores that have been examined in the last three years, particularly those in southern Illinois and Lawrence County, the sideritic massive greenish-gray clay shales may be included among the characteristic members of the Pennsylvanian succession along with the marine limestones, black sheety shales, coal beds, underclays, and underclay limestones; indeed they are almost as frequently encountered as the coal beds and underclays. When subjected to weathering these sideritic, massive, greenish-gray clay-shales exhibit little resistance and tend to disintegrate almost completely. Hence their unweathered character is probably not commonly apparent in outerop or distinguishable from that of the overlying underclays.

7) The conglomerates of the Pennsylvanian system are not widespread. These most commonly occur at or near the base of massive to somewhat crossbedded and more or less local sandstones, suggesting rapid deposition in fluctuating currents. The larger fragments of the conglomerates are of various kinds of materials, but probably ironstones and shale blebs are the most common constituents, although limestone pebbles and coal shreds and fragments are also very common. Some conglomerates consist of a sandstone matrix in which may be embedded one kind of larger fragment of shale, coal, or ironstones, others are mixtures. Not uncommonly the conglomerate is very calcareous, being composed almost entirely of fragments of limestone embedded in a sandy but very calcareous matrix. Furthermore, some conglomerates are not basal in the sandstone section but appear as though floating in the sandstone formation. Usually the base of the conglomeratic bed, if it rests upon shale, appears to be uneven. At any rate, there is a sharp change from conglomerate to shale.

It is usually not possible to identify the source of the pebbles contained in the conglomerates in the rocks penetrated in the cores. However, in a conglomerate penetrated in a drill-hole located in southern Jefferson County the pebbles scattered in the sandstone closely resembled the gray siltstone which was the member immediately underlying the sandstone. In Jefferson County a thickening of what is believed to be the Anvil Rock sandstone (which cuts down across the position of No. 6 coal bed) carries pebbles and shreds of coal in great quantity, forming a coal-sandstone conglomerate at about the position of the coal bed. In southern Sangamon County, a recently drilled hole penetrated a boulder and fragments of coal in a sandstone at about the position of No. 6 bed. Spore analysis yielded spores characteristic of No. 6 bed. At about the appropriate distance below, the drill passed through No. 5 bed in normal position.

Conglomerates of the kind described seem to be most prevalent in a relatively narrow stratigraphic zone extending from a little above the Cutler, Piasa, Lonsdale, and West Franklin limestone zone to the base of the McLeansboro. Where a conglomerate is found in the Anvil Rock sandstone it seems probable that the base of the McLeansboro may protrude into the upper part of the Carbondale formation as a channel deposit.

Conglomerates of much the same kind are found occasionally but not commonly at other positions in the McLeansboro group, and it may be that it is only because so much of the drilling has been in the lower 500 feet of the McLeansboro. Now that more holes penetrate strata 500 to 800 feet above this coal bed, the picture may change somewhat.

The Pennsylvanian conglomerates have more or less unique characteristics in two particulars. They are poorly sorted with respect to hardness: Limestone, ironstone, and shale pebbles or blebs are commonly found in the same conglomerate, unsorted as to size or character. Secondly, the components of the conglomerate are commonly exceedingly irregular in form with a conspicuous angularity or aciculate form. This is particularly true in the case of the softer materials such as shales and coal. It seems strange that such angular soft material could have been transported even a few feet along with the sand with which it is associated without being entirely disintegrated. Shale fragments of this type would even today maintain their sharp edges only the briefest time if simply immersed in water even without agitation. Some conglomerate consists of sandstone in which such fragments of coal or irregular pieces of shale have been suspended.

The fact that the type of conglomerate described is particularly common in the lower part of the McLeansboro gives some plausibility to a belief that special conditions account for its peculiarities. Any postulated conditions that are sufficiently generalized to explain ordinary conglomerates without explaining their special concentration at the stratigraphic position would be unsatisfactory. Furthermore, it seems probable that unusual conditions which would result in the formation of the angular sedimentary conglomerates of soft material would give rise to other phenomena, peculiar to the sedimentary beds of this same general period.

8) Another of the mysteries of the Pennsylvanian succession in Illinois is the origin of the variegated shales. A useful stratigraphic index of the general position of the No. 6 coal bed in southwestern Illinois is a group of variegated-reddish green, yellow, purple, and gray, clay shales lying 40 to 60 feet above the coal bed. Diamond-drill cores show that there is a good deal of irregularity in the exact position of these clay shales but they generally seem to be present near or at the position of the limestones known as the Piasa, Cutler, Lonsdale, and West Franklin. Whether or not these are the same or different limestones is still a moot question; thus far in the examination of drill-cores none has been seen in which more than one limestone appears to correspond to one or other of these beds, but generally one such limestone is present. It is near such a bed that the red shale is usually found in Madison, Bond, Christian, Fayette, Randolph, and St. Clair counties, Illinois, and in Vigo County, Indiana. Variegated shale is also found in outcrop associated with the Lonsdale limestone in Peoria, Marshall,

and La Salle counties, and with the West Franklin limestone in the Evansville region of southern Indiana. Rarely such variegated shales are seen in cores from southern Illinois.

It may be significant, in connection with consideration of the McLeansboro conglomerates described above, to note that the geographic distribution of the variegated shales corresponds closely with that of the conglomerates. Both of these phenomena may possibly be related to a common cause. At any rate the fact that there seems to be an association of two unusual conditions stimulates the curiosity as to the possibility of there being others. Two others suggest themselves: The first is the fact that coal beds No. 6 and No. 7, in the upper Carbondale and lower McLeansboro groups, respectively, are the only two coal beds of the Illinois Pennsylvanian that are conspicuously and persistently benched, pointing to the existence during their accumulation of several interrupted but individually complete coal formation periods, and several periods, possibly equally long, when peat was not accumulating. The second item of interest is the exceedingly irregular distribution of the No. 7 coal bed. In general it is thickest in the northern part of the coal field but particularly in the northern part of Peoria and in western Marshall County and again in Vermilion County and in certain parts of Indiana mainly north of Terre Haute, but even here it is quite irregular. It is not present in southwestern Illinois in Madison, Bond, and the western part of Christian County, and is irregular in Sangamon County. Whether this No. 7 coal of northern part of the coal basin is the same as the Cutler coal bed is uncertain. The distribution of No. 7 coal bed in Vigo County, Indiana, is very irregular, apparently mainly due to erosive cut-outs.

The present brief paper can do little more than call attention to some of the peculiar aspects of Pennsylvanian sedimentation and stratigraphic succession that have been discovered as a result of the study of diamond-drill cores during the last 30 months. The stratigraphic zone represented by the lower part of the McLeansboro is one of particular interest. By no means all the peculiarities of this zone have been enumerated, and until at least the more obvious ones have been listed and described, their environmental conditions can not be understood. Each unusual feature promotes speculation and suggests one or more hypotheses in explanation. Rarely are conditions more conducive for the operation of the multiple working hypothesis in developing a satisfactory theory of the Pennsylvanian sedimentation. It is an appropriate field of academic research in sedimentation, stratigraphic classification, and paleontologic and paleobotanic stratigraphy.

USE OF INTERNATIONAL BUSINESS MACHINE TECHNIQUE IN TABULATING DRILLING DATA[1]

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The International Business Machines are primarily electrically operated accounting machines, designed to reduce error and time in handling large and complicated financial records.

The system is based on punching the data into cards which form a permanent record and which may be used to compile data in a variety of ways.

There are three principal machines: (1) a punch machine, on which the cards are prepared; (2) a sorter, which mechanically arranges the cards in any desired order; and (3) a tabulating machine, which mechanically prints the data from the punched cards.

The sorter handles 440 cards per minute, and the tabulator prints the data from the cards at the rate of 80 cards a minute.

All cards used in the International Business Machines are of the same size and kind of paper. There are 80 vertical columns across the card, allowing one number or letter to be punched in each. Within a column there is space for twelve accurately located holes to be punched. The position of the hole or holes in any one column determines the number or the letter punched.

When the punched cards are fed into any other machine, these holes permit electric contacts to be made which mechanically sort the cards, list the data, or reproduce the punched holes.

The Coal Division of the Illinois State Geological Survey has adapted the use of these machines to facilitate the handling of tabulated geological data that accompany structural contour maps. Thus it is possible to assemble the necessary data for each datum point for use both in the preparation of the map and for publication.

The information for use with structure contour maps is first written on the lower portion of the "log record" card. Along the upper part of the card are the column headings for the information that is to be punched on the card.

The card is then placed in an Alphabetic Punch machine, which has a keyboard similar to that of a standard typewriter, and the data are punched into the card. Simultaneously with the punching operation, the characters are printed along the upper edge of the card. The card shown in figure 1 has been punched from the information written on it.

As the amount of information which can be punched on any one card is limited (by the number of columns in the card) to 80 characters, it is frequently desirable to use more than one card for any one well record. In such a case, the first card shows the full location of the well by township, range, section, and fraction of section, the ground elevation above sea-level, the year drilled, type of hole, total depth, county map number, company name and number, and the depth, altitude, and thickness of two coal beds. The second card repeats the location and county number but also gives the farm name and number and data regarding two other formations. Additional cards that may be needed repeat only the location and county

[1] Published with the permission of the Chief, Illinois State Geological Survey.

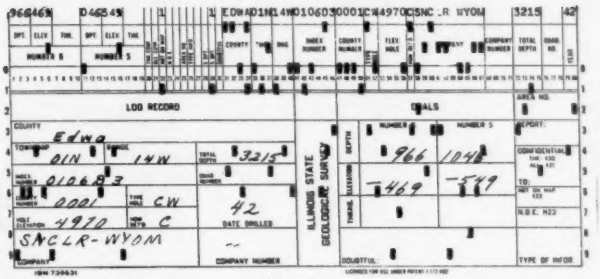

FIG. 1.—Well log record card punched from handwritten data on IBM card.

number (for identification), and give data on any additional two formations. Although the location and county numbers are punched on all the cards for each datum point, these items are printed only once when the data are listed.

The cards are mechanically arranged in the desired order by the sorting machine. This machine will sort according to one column at a time, arranging the cards by the positions of the holes in that column. Thus the cards when removed from the pockets of the machine will be in numerical order 0-9. Each letter is represented by two holes, so that the cards must be sorted twice on a column in order to be arranged alphabetically.

Suppose we wish to tabulate data on 350 wells with two cards for each well, or a total of 700 cards. It takes about 25 minutes to sort all the cards by county number and by location in township, range, section and fraction of section. It takes another 15 minutes to print the list. Each line of printing represents one card.

The printing is done on the Alphabetic Accounting machine or tabulator. The cards are placed in the upper hopper and pass one at a time between two sets of brushes and rollers which make the electric contacts, and then the cards emerge in the lower hopper. The electric contacts send impulses through the machine to a plugboard where they are connected by wires to the type bars.

Figure 2 shows a list of tabulated data arranged by county number. Figure 3 shows a list from the same cards arranged by location.

The data need not be printed in the same order in which it appears on the card or in these lists. This permits considerable flexibility in the use made of the cards.

If the cards have been checked and are known to be correct, there is no further need to proofread these lists.

These lists may be photographed, reduced, and planographed for publication.

In addition to straight listing of data, this machine will add or subtract and print totals. It will omit certain punched data, enabling the same cards to be used for Survey lists and also for publication where confidential information is to be withheld.

By using a reproducing punch machine, it is possible to take the correctly punched cards and mechanically punch all or part of the information into a new set of cards. This is much faster than manual punching.

For instance, we compile mechanically the data for use in preparing maps showing the interval between

LOCATION OF HOLE			COUNTY NUMBER	TYPE OF HOLE	OPERATOR	OP'R'S NUMBER	SURFACE ALTITUDE	TOTAL DEPTH	QUAD NUMBER	YEAR DRILLED	NOLLYMBOGHI THICKNESS	COAL NO 6				COAL NO 9			
TOWNSHIP	RANGE	SECTION										DEPTH (FEET)	ALTITUDE (FEET)	THICKNESS FT	THICKNESS IN	DEPTH (FEET)	ALTITUDE (FEET)	THICKNESS FT	THICKNESS IN
					EDWARDS NOV 15 1945														
1N	14W	6 D3	1	CW	SNCLR WYOM BIERHAUS A	1	4970 C	3215		42		966 709	469• 212•			1046 912	549• 415•		
1S	10E	16 E7	2	CW	NELSON DEV REID A	1	4270 D	3388	239	43		940 666	513• 239•			1034 893	607• 466•		
1S	11E	7 G6	3	CW	MAGNOLIA GOULD E	1	5070 C	3350	239	42		926 698	419• 191•			1012 888	505• 381•		
2S	10E	8 E7	4	CW	NELSON DEV BUNTING C	1	4690 C	3447	239	43		975 709	506• 240•			919	450•		
2S	10E	19 A1	5	CW	SUN OC MCKIBBEN R	1	4370 D	3394	239	42		938 646	501• 209•			1015 862	578• 425•		
3S	10E	8 D2	6	CW	SNCLR WYOM PERKINS H	1	4140 C	3410	239	42		870 604	464• 190•			1019 837	605• 423•		
3S	14W	17 H1	7	CW	HALBERT R C PROCTOR	1	4060 D	3100	238	43		844 572	438• 166•			918 792	512• 386•		
2S	14W	20 A6	8	CW	KINGWOOD OC COWLING W	1	4670 D	3247	239	43		920 651	461• 184•			1023 879	556• 412•		
1N	10E	18 D2	9	CW	MIDSTATE OC MCKINLEY	1	3940 D	3350		43		946 686	552• 292•			1041 904	647• 510•		
3S	10E	13 H8	10	CW	MIDSTATE OC COAD W		4830 C	3240	239	43		964 711	481• 228•			1055 934	572• 451•		
1N	14W	10 F1	11	CW	MAGNOLIA MATTHES	1	4130 D	2918	234	43		790 548	377• 135•			905 738	492• 325•		
1N	10E	4 C5	12	TD	ILL PROD BARBER H C	1	4420 C	3301		43		955 710	513• 268•			1030 918	588• 476•		
1N	10E	9 A3	13	TD	RYAN FRTNR RALSTON	1	4450 C	3336		43		984 721	539• 276•			1063 943	618• 498•		

FIG. 2.—Wells listed by county number.

two formations, by using our standard "log record" cards. This is done by reproducing the location of the well and the elevations of all formations into a new set of cards containing one card for each well.

The cards are then run through the tabulating machine which me-

LOCATION OF HOLE			COUNTY NUMBER	TYPE OF HOLE	OPERATION	OPER NUMBER	SURFACE ALTITUDE	TOTAL DEPTH	QUAD NUMBER	YEAR DRILLED	INDEPENDENCE TRENCH FOOD	COAL NO. 6			COAL NO. 9			
TOWNSHIP	RANGE	SECTION										DEPTH (FEET)	ALTITUDE (FEET)	THICKNESS FT	IN	DEPTH (FEET)	ALTITUDE (FEET)	THICKNESS FT	IN
					EDWARDS NOV 15 1945														
1N	10E	4 C5	12	TD	ILL PROD BARBER H C	1	4420 C	3301		43		955 710	5135 2280			1030 918	5880 4760		
1N	10E	9 A3	13	TD	RYAN FRTNR RALSTON	1	4450 C	3336		43		984 721	5390 2760			1063 943	6180 4980		
1N	10E	9 C5	14	TD	BANDER OLDS IBBOTSON G	1	4550 D	3294		43		1003 737	5480 2820			1082 961	6270 5060		
1N	10E	13 A1	15	TD	WALSH DYE TULL W S	1	4630 C	3302		42		934	4510		•0	1013 895	5300 4120		
1N	10E	16 G3	16	TD	ARMOUR ETL RALSTON	2	4710 D	3319		43		1000 737	5290 2660			1076 957	6050 4860		
1N	10E	18 D2	9	CW	HIDSTATE OC MCKINLEY	1	3940 D	3350		43		946 686	5520 2920			1041 904	6470 5100		
1N	14W	6 D3	1	CW	SNCLR WYOM BIERHAUS A	1	4970 C	3215		42		966 709	4690 2120			1046 912	5490 4150		
1N	14W	10 F1	11	CW	MAGNOLIA MATTHES	1	4130 D	2918	234	43		790 548	3770 1350			905 738	4920 3250		
1S	10E	16 E7	2	CW	NELSON DEV REID A	1	4270 D	3388	239	43		940 666	5130 2390			1034 893	6070 4660		
1S	11E	7 G6	3	CW	MAGNOLIA GOULD E	1	5070 C	3350	239	42		926 690	4190 1910			1012 868	5050 3810		
2S	10E	8 E7	4	CW	NELSON DEV BUNTING C	1	4690 C	3447	239	43		975 709	5060 2400			919	4500		
2S	10E	19 A1	5	CW	SUN OC MCKIBBEN R	1	4370 D	3394	239	42		938 646	5010 2090			1015 862	5780 4250		
2S	14W	20 A6	8	CW	KINGWOOD OC COWLING W	1	4670 D	3247	239	43		928 651	4610 1840			1023 879	5560 4120		

FIG. 3.—Wells listed by location.

chanically subtracts one elevation from another and prints a list showing for each well, its location and the interval from the No. 6 coal to each of the other formations.

The machines can also be adapted to handling chemical analyses of coals or other types of data.

PSYCHOLOGY AND EDUCATION

A FUNCTIONAL CONCEPT OF GUIDANCE

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Educationists and psychologists have been advocating the necessity for guidance in the secondary school for so long that it comes as rather a shock to learn that a canvass of the situation reveals the fact that most secondary schools still have no definite guidance programs. To discover why this situation exists, a number of superintendents and high-school principals were consulted. Their responses indicate that while they are convinced of the necessity for creating guidance programs, they do not know what to do. They still look at guidance as a separate program—something unrelated to instruction. They look at it as an end in itself rather than as a means to an end. They express a willingness to create guidance programs if they can employ specialists in guidance. In their absence, however, they are at a loss as to what can be done. This is because the approach to guidance has emphasized it as a separate program. It appears that what our secondary school administrators need is a functional concept of guidance, one that relates guidance to the school's primary function, the imparting of instruction. Possessed of such a concept, it is believed that most administrators would create adequate guidance programs.

Among the many questions which they ask about guidance the following four are the most common: What is guidance? What conditions indicate a need for guidance? In case a guidance program is developed, can members of the present staff act as advisors or counsellors? (In other words, What are the qualifications of advisors and counsellors?) What are the duties of advisors and counsellors? In this paper, an attempt will be made to answer these questions, in turn, in the hope that out of their answers a functional concept of guidance will emerge.

THE NATURE OF GUIDANCE

In the final analysis, guidance is nothing new. It is as old as instruction itself. It is too often thought of as something apart from, or at least something supplementary to, instruction. Only too seldom is it identified with instruction. The term "instruction" has been so closely tied up with the idea of subject-matter that its real connotation with respect to pupils is often overlooked. In the mind of the average individual it is considered as referring to teaching some particular subject. In this concept of instruction, guidance has no place as it becomes a thing apart from instruction. When the term "instruction" is so used as to place the emphasis on the pupil rather than the subject however, as when used to refer to the teaching of pupils, guidance is conceived of differently. Immediately it becomes an integral part, a correlative of, instruction. This is the concept that teachers must accept. Teachers, acting as advisers, should not accept their duties as just other

tasks or burdens placed upon shoulders already bearing heavy loads.

One might argue then, and with some validity, that guidance is a "fad or frill"—that it is only another name for what the school is now doing. This argument would be sound enough provided it might be assumed that the school is actually doing what it has accepted in theory as its task. This assumption is not warranted, however, as the tendency has been to confound education with textbook learning. The high-school curriculum is still traditional, and there is a tendency to measure education by the number of courses completed. This is the result of the present plan of educational organization. The setting up of a program of guidance is an attempt to change the plan or organization in such a manner as to place the emphasis where it belongs, upon the pupil rather than upon the subject. In other words, it is an attempt to make education functional.

THE NEED FOR GUIDANCE

A survey of the attitudes of children of any high-school reveals the need for guidance. If attitudes were always social and never non-social or anti-social, if they were always intellectually correct, and if pupils were always properly conditioned emotionally, there would be little need for guidance. But high-school children often possess attitudes that are perverted. The school is society's agency for developing ideals of good citizenship. It has not met its full responsibility when it restricts its efforts to the inculcation of aesthetic ideals, to the cultivation of intellectual attitudes, and to the development of special abilities.

The problem of guidance has become intensified as the result of fundamental social changes. The industrialization of society and the technological advances in agriculture have brought about a major reversal in the numerical relationship of the rural and urban population. As a result, children have been concentrated in industrial and trade centers and have been released from productive activities. They have found themselves in ever-increasingly large numbers in school with no other place to go and with nothing else to do. Frequently they have found the school inhospitable both in its organization and in its offering. Conditions are favorable, therefore, for the development of perverse attitudes.

Fortunately, education is undergoing a change in both its philosophy and its emphasis. Modern education is shifting its emphasis from subject-matter to children. The school has come to look at the child as a living organism developing as a result of his interaction with his environment. As long as the emphasis was upon the subject-matter or the teacher, guidance was unknown. Now that education has shifted its emphasis to the individual, and now that education is thought of as a process of adjustment, the necessity for guidance becomes apparent. The educative process now becomes one of guiding the individual. And so guidance and true education becomes synonomous, and guidance must be embraced as a means of making the work of the school functional.

QUALIFICATIONS OF ADVISERS OR COUNSELLORS

In any program of guidance, advisors or counsellors occupy the key position, and the success of the program can be measured largely by the extent to which advisors are individually successful. High-school administrators are generally agreed

upon this point. They believe that the greatest obstacle in the way of developing a satisfactory guidance program is the lack of suitable personnel. The following question naturally suggests itself: Can any instructor become a successful advisor? The answer is simple: Yes! Provided that that instructor is, in the real sense of the term, a teacher.

Guidance, as has already been pointed out, is not new. Many teachers—all those deserving of the title—have practiced guidance without so labelling it. The good teacher has always been an advisor, whether he has realized it or not. The time is past when the best teacher is considered to be that one whose students memorize the most facts. Today we consider the best teacher to be that one who is the most successful in assisting his pupils in developing themselves. To do this successfully, he must perform the functions of an advisor. From this it may be concluded that the qualifications of a successful advisor are included within those of a successful teacher. This means that the average teacher must expand his concept of the teacher's function, and that the teacher training institutions must do likewise.

The successful advisor must have a thorough understanding of the aim of the guidance program. This must necessarily be based upon an understanding of the philosophy which generates the program. An understanding alone is not sufficient, however. It is the attitude of the advisor which accompanies this understanding that is important. The advisor must be sympathetic to the program.

It may be well to add that the advisor should be more than sympathetic with what is attempted—he should be enthusiastic about it. As so often happens in teaching, many individuals fail as advisors because of this lack of enthusiasm.

This list of qualifications is not intended to be all-inclusive. It includes only those which are generally considered to be the most important. The successful advisor must undoubtedly possess other qualifications, but any teacher in possession of those just enumerated has little to worry about in respect to his becoming a successfud advisor.

DUTIES OF ADVISORS AND COUNSELLORS

The duties and activities of advisors grow out of the aims of guidance. What the advisor does, or what he should do, must necessarily be determined by the goals he is attempting to attain.

Any plan of guidance is, in part, an administrative device created for the purpose of bringing matters of administrative import to the attention of pupils who can be influenced much more easily in small groups than through the medium of large assemblies or bulletin boards. From this it follows that one of the duties of advisors is to bring administration and pupils into closer cooperation. It is through the advisor that each obtains the point of view of the other.

Again, the guidance program should aim at the development of the proper relationships between teachers and pupils. This was discussed, in part, in the preceding paragraph, but is much broader than indicated there. If guidance is to result in the development of this relationship, it will be because the advisor assumes certain duties efficiently. Pupils will follow the leadership of someone who shows an interest in them, but one who does not will be forced to drive his pupils rather than lead them. High-school pupils are particularly clever in detecting sham. The interest of advisors should be

demonstrated in all school activities. Likewise, the interest of advisors must carry outside the school into the life-activities of pupils. The ideal relationship between advisor and pupil is one characterized by mutual respect and confidence. Such respect and confidence are developed, largely, as the result of understanding. Understanding will follow interest. An advisor should assume, as part of his duties, any responsibility that results in demonstrating to pupils his interest in them.

The guidance program, as has already been stated, is aimed at individual adjustment. In attempting to attain this aim, the advisor performs one of his most important functions. The task of providing individual guidance involves a number of specific duties. This is a more or less routine task but its importance cannot be over-emphasized. The extent to which guidance is satisfactory is determined in part by the extent to which the advisor's data are complete. To advise properly one must necessarily be possessed of as complete a case history as possible. Advisors must always be on the alert to discover new facts about pupils. The technique of counseling is important. Each advisor must develop his own technique, however, he must experiment until he discovers one that is satisfactory for him. Certain general rules should be followed, of course. The advisor should be possessed of facts, he should be sympathetic, and both he and the advisee should be in the proper frame of mind. Beyond this his technique should be individual. If the advisor, however, has the interest in his work and in his pupils that he should have, if he is enthusiastic, and if he has the confidence of his pupils he need worry little about the development of a proper technique. The advisor should be on the alert for situations demanding guidance and should provide it where necessary. He should conceive of guidance in its broadest sense as covering educational, vocational, social, and health matters.

SUMMARY

Guidance is too often thought of as a new function, recently added to those previously accepted by the secondary school. Such is not the case. The development of a guidance program is only the creation of a new device for the attainment of an old function. Its aims are to be found in those of education in general. It is only another means of attempting to make education functional. Changing conditions and a changed attitude toward education have necessitated the creation of additional ways of attaining previously recognized goals. With this concept of guidance clearly in mind, it is evident that the duties which a guidance program imposes upon teachers are not new ones but are the same as those that the best teachers have always accepted. The guidance program creates a situation in which these duties can be most efficiently performed.

ORIENTATION IN A TEACHER-EDUCATION PROGRAM

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In developing the new undergraduate teacher-education program at Northwestern University, which was inaugurated in the fall of 1945, consideration was given to the relative emphasis which should be given to orientation. After carefully analyzing a number of studies on college orientation courses, the books prepared to serve as texts in such courses, and the efforts of other universities to provide such courses, it was concluded that the two principal aims responsible for offering such courses, namely, that they give the student perspective and afford teachers a basis for guidance, could be achieved through a complete, well-balanced curriculum in which courses specifically dedicated to "orientation" were not offered.

As the new program was finally worked out, study is divided into unit courses, and the four-year teacher-preparation program is comprised of sixteen units. Eight of these are of the "integrated" type. In other words, they are concerned with large cultural areas, cut across traditional subject-department lines and utilize a staff of instructors representative of the best scholarship in their respective fields. At the completion of his four-year program of study, the student will have had an opportunity to develop broad understandings and skills. He will be "at home" in his physical world and in his social environment, equipped to seek his fullest possible self-expression in literature, philosophy, music, the arts, and scientific exploration.

Organization of the teacher-education program at Northwestern, then, reflects the viewpoint that orientation is not something which begins and ends at a certain time in a student's life or can be pigeon-holed. It is a continuous process. Nor is it something which the student can achieve under the guidance of a single person or a small group of faculty persons. It requires a number of teachers and it calls for teachers who have scholarly competence equivalent to that possessed by those who teach most advanced courses in a given field.

As students who enter the teacher-education program have made education their professional choice, their problem differs from that of other entering college students in that they need specific orientation to this definite professional area. Such orientation should be continuous and should be a part of the entire four-year program, just as orientation to other large cultural areas is achieved through the liberal education aspects of the whole four-year program. It follows, then, that professional training should begin in the freshman year and continue throughout the entire college career. Adequate professional orientation is basic to realization of maximum potentialities in college life.

In designing the freshman professional course at Northwestern, the more accepted principles of curriculum construction serve as guides. Factors of motivation are capitalized. The course requires the services of a group of instructors, so it is organized in a logical sequence of units to provide maximum continuity. The objectives for each unit

are stated in clear-cut terms, and the content and learning experiences are carefully selected to realize these objectives. Materials are screened so that only that which is relevant and significant to the student is included. Applications are concrete and constitute a logical part of each unit. Wide varieties of methods and aids are employed. Early analysis of the needs of each individual student forms the basis for immediate remedial treatment. Finally, complete records of the activities and effectiveness of each unit are made as a guide to future offering of the course.

The year's professional study, called "An Introduction to Personal and Professional Development," begins with a consideration of those needs which are occasioned by the student's adjustment to a new institutional environment. This involves an acquaintance with the university community, the wider community in which it is situated, some of their resources, and how they may best be utilized by the student. Emphasis is placed on assisting students to meet individual needs in such areas as health, recreation, and communication.

This year's course is planned from the viewpoint that, when a professional course is developed in terms of the personal and professional needs of students, a wide variety of methods and aids must be employed, which, in turn, makes it necessary that a representation of specialists participate in the instruction. The course is planned by specialists and representative specialists teach it. At Northwestern, three professors representing teacher education, child development and reading and health education constitute the directing committee present at every class session during the first two quarters. This committee, augmented by specialists in such fields as visual aids, personal poise and appearance, nutrition, occupational information and speech, plans the year's sequence and teaches the major portion of the first two quarters.

Since one of the basic needs of freshmen who are planning to enter teaching is in the field of oral communication, the third quarter of the year's course is devoted solely to building speech competencies. Students are placed under a professor of speech education. He has assisted in developing the course during the first two quarters, has worked sufficiently with the students to be cognizant of their speech needs, and has access to the resources of the School of Speech in meeting these needs.

The plan of the teacher-education program at Northwestern has been favorably received by the profession, and it seems that there is considerable agreement upon the validity of the approach. It reflects a trend in teacher education anticipated by the *National Survey of Teacher Education* published in 1933 and by later publications such as the Harvard Report on *General Education in a Free Society.*

Our experience with the new program leads us to the conviction that a teacher-education program planned in terms of segmented courses with student electives, and in which perspective is given through orientation courses, is less effective than a program planned in terms of areas, with students' choice limited mainly to the selection of teaching fields, but with individual needs of students recognized within the units. Thus, for instance, the Northwestern program sets aside a block of time—one-fourth a year's work—to be devoted to "The Fine Arts". Within this unit the individual needs and capacities of each student are recognized, but no student is permitted to omit

study in an area which is calculated to develop those intellectual and aesthetic resources that are encouraged by acquaintance with philosophy and the arts, and which hence is deemed essential to providing adequate perspective. Thus, teachers receiving this preparation will not be in the position of the two-thirds of public school teachers which the National Survey of Teacher Education showed had had no training in fine arts either in college or high school.

My experience with the new teacher education program at Northwestern University leads to several convictions. Offering courses designed to fulfill the broad, general objective of "orientation" is less adequate and effective in meeting needs of students than offering units of work which are designed to care for different aspects of the orientation needs and in varying degrees. By designing a complete program to develop the specific competencies and understandings which are characteristic of the cultured citizen and the successful teacher in a given field, the need for orientation will be satisfied without more specific attention. Orientation cannot be achieved through a single course or even in the teaching of a single department. It can be fully achieved only through a well-planned total teacher education program in which the many agencies of a university are coordinated to discharge fully the teacher education function.

A PROPOSED SCIENCE CURRICULUM FOR THE PUBLIC SCHOOLS

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The results of numerous research investigations and the examination of several hundred courses of study in science, show the following facts:

Fact 1.—The science curriculum of the American schools historically has been based upon three questionable hypotheses: (a) That through science study, the human mind can be strengthened in its innate "faculties" or capacities; (b) that the best values of science teaching are classical rather than utilitarian; and (c) that the chief immediate function of science in the high school is that of pre-professional or college-preparatory training.

Fact 2.—The majority of students in the schools of America traditionally have been unable to profit in any large degree from the classical type of science curriculum. This for three reasons, namely: (a) The curriculum was too difficult for those within the normal span of native intelligence; (b) the program was poorly allied with the apperceptional background and the real needs of the students; and (c) the methods of teaching were sometimes—though not always—faulty.

Fact 3.—As a result of the hold that classical and traditional values and methods have had upon the schools, the modern science curriculum in most schools is still anachronistic, marking a distinct hysteresis between social needs and educational planning to meet those needs.

Fact 4.—Although some of the burden of responsibility must rest with the teachers of science themselves; some of it with the lethargy of public opinion; and some of it with the college professors who have written the science textbooks and determined the college entrance requirements, a large share rests with the inertia and lack of social vision among public school administrators and their boards of education.

So much for the facts that are chiefly historical. Some facts indicative of the future may perhaps be stated somewhat as follows:

Fact 1.—There appears to be some hope that the near future will see a really substantial financial support for science teaching, with adequate funds for plant facilities, laboratory equipment, and teaching staffs.

Fact 2.—In the present, we are experiencing a transition from classical and pre-professional objectives to the utilitarian or vocational-domestic objectives. But the present chaos is so complete that one needs merely examine a few dozen courses of science from American high schools to see that any clear-cut and universally acceptable statement of objectives—to put the matter poetically—will likely be a long time a-borning. The fact was clearly pointed out by the Committee on the Function of Science in General Education[1]; and in the subsequent eight years the situation has improved but little.

Fact 3.—The trends in curriculum indicate a significant movement now under way to integrate science with numerous areas of human living. The evidence is in such courses as those dealing with the science of home sanitation; the chemistry of cooking; the

[1] Progressive Education Association, *Report of the Committee on the Function of Science in General Education*, pp. 13-17. New York: D. Appleton-Century Co., Inc., 1938.

relation between physiology (especially endocrinology) on the one hand and human personality and behavior on the other; courses in automobile mechanics; science applied to home nursing; the science of agriculture and horticulture; science in relation to marriage, eugenics, child care, pre-natal care, etc.; science in courses on consumer purchasing and propaganda analysis; home building; home making, and the like. One looks in vain through school reports of half a century or a century ago for such courses. By contrast, the courses were highly regimented. The content was encyclopaedic knowledge to be memorized. There were vast lists of scientific classifications. But there was very little laboratory experiment and—except for the examination of so-called natural objects—little activity of any kind and almost no integration whatsoever. Perhaps the apex of classical terminology was reached with Boston's program for 1870, in which was listed a course that may have been physics or mathematics or both. Taught in grade twelve, it was called "'The Theory of Indeterminates of the Infinite and the Infinitesimal of Imaginary Quantities.''[2]

Fact 4.—The fourth fact in evidence is a corollary of the third. The high school in particular, once considered as the seed-bed for each year's crop of college freshmen, has at last recognized the fact that 75 or 80 percent of high-school graduates will not go to college.[3] The college entrance requirements are beginning to lose their dominant influence upon the high-school curriculum; and the science program, partially freed from these bonds and partially impelled by the obvious needs of the mass of students, is beginning to descend from its ivy-covered tower to work in the home, the machine shop, the garage, the farm fields, the nursery, and even in the kitchen. This fact does not mean that science has deserted the high prerogatives of speculative investigation into the nature of the cosmos or the search for eternal verities and respectable principles. But it does mean that that part of its offering which makes up the public school curriculum at last is being measured in terms of the most probable and best life needs of the students. It means that specialization is at last being left to the colleges and the institutes and to the technological and scientific foundations.

With these facts now as a background, there is a temptation to project a future curriculum for purposes of contrast. Such prediction is perhaps a combination of measuring the trends and of expressing a hope. The latter part may be permissible if it rests upon reasonable probabilities.

For such a contrast, then, let us point to the requirements in science recommended by the Committee on the Course of Study of the National Education Association of 1876[4]. For the years of elementary education it recommended geography and some oral lessons in natural philosophy and natural history. That was all. And for the high school it recommended natural philosophy, chemistry, physics, botany, zoology, and physiology. That was 1876.

Now, the following program, it may be hoped, will be typical for the school by 1976. And it is proposed only after most careful examination of present trends, the opinions of

[2] *Annual Report of the School Committee of the City of Boston, 1870*, p. 309. Boston: 1871.
[3] Gwynn shows 22% going to college (Gwynn, J. Minor). *Curriculum Principles and Social Trends*, p. 347. New York: Macmillan Co., 1943.
[4] National Education Association, *Journal of Addresses and Proceedings*, pp. 58-68. For the year 1876.

competent curriculum specialists, and the reports of many investigations which have inquired into the needs of growing boys and girls in the present social order.

I. *For primary grades:*
- Nature study of local flowers, birds, trees, resources, and weather phenomena;
- Health factors and practice in diet, cleanliness, and sickness prevention;
- Local science and industry, with excursions to dairies, museums, farms, mines, lakes, forests, rivers, factories, etc.;
- Beginning of botany and zoology through school gardens, excursions, the raising of pets; collection of specimens;
- Home science in practice of safety, simple cooking, sanitation; and introduction to costs and values of food and clothing.

II. *For upper elementary grades and junior high:*
- Geography in integrated units with geology, botany, history;
- Botany and zoology through field excursions; study and collection of specimens; beginning of textbook study;
- Geography through integration with agriculture on school farm; experiment with study of soil, erosion control, etc.;
- Human biology and physiology begun through study of health; elementary genetics; laboratory work in diet, cooking, sanitation, child care, and consumer purchasing—all in school home economics and nursery departments or in school cottages especially equipped;
- Chemistry through integration with home economics in laboratory study of foods, textiles, woods, varnishes, paints, cleaning compounds, and other common articles of home consumption;
- Chemistry and health integrated in study of local sources of water and milk supply, home cooking and canning, diet, bacterial analyses, and pest control;
- Astronomy through observation and beginning textbook study;
- Home mechanics integrated with general home planning, design, manual training, industrial design, home repair;
- Automobile mechanics and elementary physics through shop work in specially equipped industrial shops of the schools;
- Health and mechanics integrated in safety education, analysis and correction of hazards in the home; organization of safety patrols;
- Agriculture, geography, and geology integrated with zoology, horticulture, and botany in experience program with school farm, involving stock raising, seed selecting and hybridization, pest control, conservation, reforestation, etc.

III. *For grades 9-12:*
- *Required:* human biology, including genetics; physical and mental health.
- *Alternate or elective:* all other areas of science, with the understanding that any course will be offered for which there is demand by sufficient students to comprise a class.

In curriculum planning for the science program, both in the required and alternate courses(but not in the free electives), a formula can be established to determine whether any particular fact or skill should be required. The formula may be stated as *Utility plus One,* the "One" being either universality of use, frequency of need, or cruciality of need. This simple formula for these courses can be applied as the criterion for every single element of the science curriculum, every item of every textbook, and every skill taught in the laboratory. Let us apply the formula, for example, to Newton's familiar law. Is this law useful—does it have what we call "Utility"? Undoubtedly it has. Then we must ask, Is this knowledge such as to be universally needed? That is, is it used by the butcher, the baker, and the candlestick maker? Apparently not; but it can still be justified if it has frequency of need by the majority of people. But it does not have. Then, does it have cruciality? Again the answer is no. So, though it does have utility, it will not be required.

By contrast, certain facts about automobile driving would be required because they meet the criterion of universality. Some facts of first-aid would be required because of cruciality.

The protest is often made that these newer trends in the science curriculum introduce materials of learning that are not academically respectable. The answer is simply that anything which adds to human happiness is academically respectable. Anything that reduces human drudgery in the kitchen, on the farm, in the factory, or elsewhere; anything that reduces sickness, injury, superstitution, gullibility, wastefulness, and other sources of human misery—anything, in short, which takes the child where he lives and improves his health, citizenship, vocational competence, personality adjustment, or worthy use of leisure time, is, *ipso facto,* respectable. Without class distinction, the new program moves toward the ultimate goal of all living, the goal of human happiness.

Science should be a part of the work of all elementary grades and of from two to four years of the high school.

The objectives for the teaching of science should be:

1. To develop skills and acquire habits and knowledge of science that will function immediately and in the ordinary lives of all students;

2. To develop appreciation of the full part played by science in our changing technological and social order;

3. To develop appreciation of the method of science as involving control of variables, freedom from prejudiced observation, cautious accuracy, the withholding of judgment, and the exact use of principles;

4. To develop appreciation of scientific development as a heritage from the labors of many men and generations of men; and a sense of responsibility socially in putting the resources of science to desirable uses;

5. To acquire a utilitarian mastery of the specific science skills most commonly needed in such frequent or crucial situations as involve health habits; safety; food; consumer purchasing; automobile mechanics; vocations; recreation; household management; and the obtaining of accurate information and professionally competent advice;

6. Recognition of science as the essential avenue of civilized man in his long search for truth; and, consequently, an ideal which holds, as essential for human progress, the rights of free scientific inquiry at all costs and the dissemination of scientific evidences of whatsoever kind.

INTERESTS AND CHOICE OF TEACHING FIELD

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Illinois State Normal University, Normal

Personnel practices of colleges for many years have involved the use of intelligence tests, reading tests, and other achievement tests. Many investigations, using the data provided by such tests and revealing significant aspects of college populations, have been reported. Only recently have schools begun to use measures of interest as a part of the procedure for evaluating incoming freshmen. At Illinois State Normal University we have been using the Kuder Preference Record for two years. This is a report of an exploratory investigation of the results.

Only the data for the freshmen who entered in September 1944 have been tabulated and made available for interpretation. Owing to the irregular entrance of students this past year, including late registration, an unusually heavy second semester registration, and even a mid-semester registration to accomodate veterans, the administration of the Preference Record to all freshmen entering during the current year is not yet complete. The 279 students whose scores are presented do not represent all freshmen of last year; for a number of reasons the inventory was not administered to about 20 of them. Virtually all of them are women, so no effort has been made to take sex differences into account. Since the data are presented in terms of centiles for the appropriate sex, any distortion which might result from not separating the sexes is largely removed.

The main purpose of this investigation is to discover what differences there are between the interests of the students in the several divisions or curricula into which they are segregated. We have 17 divisions from which entering students must make a selection. They may choose to be elementary teachers, teachers of agriculture, industrial arts, music, secondary school teachers of English, Latin, biology, or chemistry, or any one of several others. This is of course their major field. They choose also minor fields of preparation. This study is concerned only with the choice of major fields.

Before considering the particular curricula, knowledge of the interest distribution of the group as a whole is desirable. This information is shown in Figure 1. The Kuder categories are listed across the top and are as follows: mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical. The centile scale is given at the side. The longest line under each category heading indicates the range, the heavier, shorter line, the inter-quartile range, and the horizontal line the median centile. The centile scores provided with the Kuder Profile Sheet are based upon 515 college students.

That Illinois State Normal freshmen cover the full range in every category is the first observation that may be made from the chart. The distributions in the majority of the categories do not differ very much from the normative group. In two categories there is a marked difference, namely the persuasive which is noticeably low, and the social service which is distinctly high. The median centile for the persuasive distribution is 23.2 and for the social service is 76.4. It is unlikely that these deviations, each approximately equal to Q, are attributable to chance.

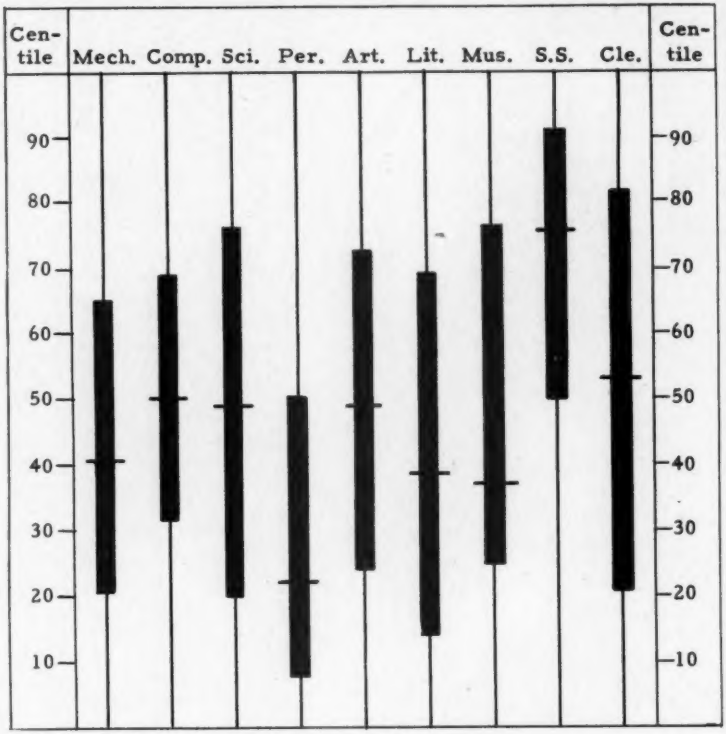

FIG. 1.—Distribution for all freshmen.

Satisfaction of a desire to render service to society is a large untaxable portion of the teacher's income, so it is fortunate that our students have so much of this interest to be satisfied.

The salesman or public relations person is most typical of one having high persuasive interest. It is clear that our students are not interested in selling, at least in the narrow sense of the term. Whether an interest in selling ideas to students is related to the persuasive category is unknown. We cannot say that this low persuasive interest is undesirable. If these data permit any generalization of any sort, they are worth the conjecture that the teacher's relatively underrated role in the community may result in part from too little persuasive interest.

All of the usual cautions that must be observed in dealing with central tendencies must be observed. There is a full range of interest in all the categories: the data show the central tendency only.

Of the 17 divisions already mentioned, special attention is given chiefly to those in which the largest number of freshman students are

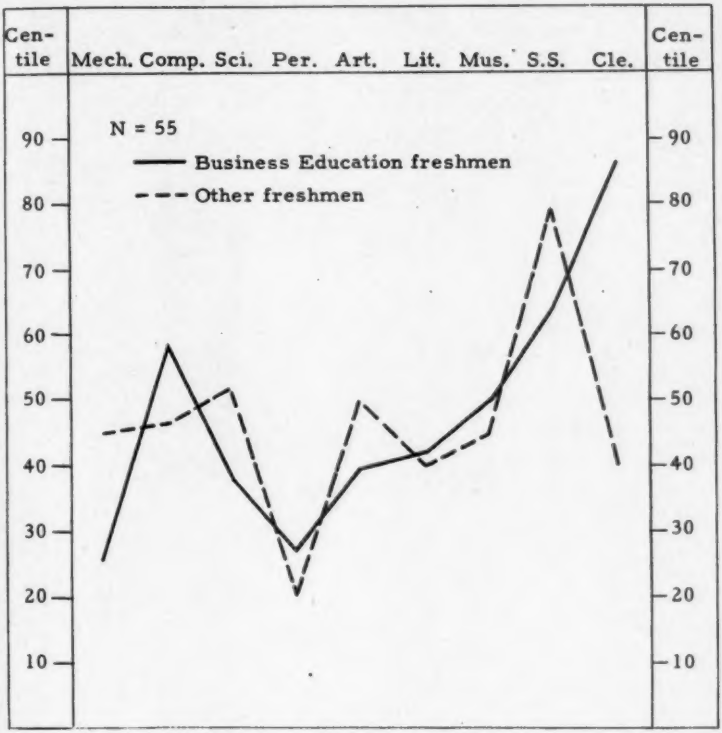

FIG. 2.—Median interests of Business Education freshmen.

enrolled. These are business education, with 55; elementary, with 45; and home economics, with 41.

The median interest scores of the business education freshmen are shown in Figure 2. The heavy line connects these median interest centiles, while the dotted line connects the medians of all other freshmen. The most significant feature of this chart is markedly higher clerical interest shown by the freshmen of this group. The difference between the means is significant at the one per cent level. This difference is in a direction we should expect. Inasmuch as the business education curriculum includes accounting, the degree of computational interest is also of special concern. The median computational interest is found to be higher for these students than for other freshmen, and the difference, though not so large as in the case of the clerical, is statistically significant at the one per cent level. The business education students have a median social service interest which is lower than the median for other students, but the difference is not statistically significant. Other interests do not differ greatly from those of the other students.

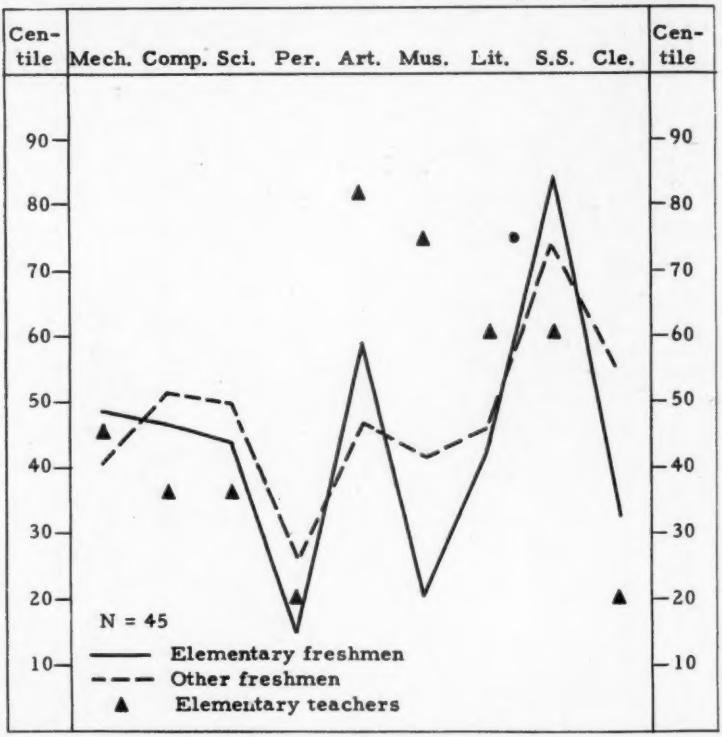

FIG. 3.—Median interests of Elementary freshmen.

The profile of median interests of the freshmen enrolled in the elementary curriculum is shown in Figure 3. The data are represented in the same way as in the preceding chart. In addition to the medians of the elementary students, and other freshmen, the median centiles of 20 elementary teachers, provided by Kuder, are shown by the small triangles. There are large and very probably significant differences between the elementary teachers and the prospective elementary teachers in the art and literary categories. This latter difference is especially noteworthy, since our elementary freshmen are lower in literary interest than other entering freshmen. The difference is statistically significant at the one per cent level. The higher median social service interest shown by the elementary students is not significant even at the five per cent level.

Figure 4 shows the median centiles for the 41 home economics students. The most noticeable feature of this chart is the close similarity of these students to other freshmen. Only at three points is there much difference, namely the lower literary and persuasive interests of the home economics students, and their higher social service interest. Only this latter deviation reaches or ex-

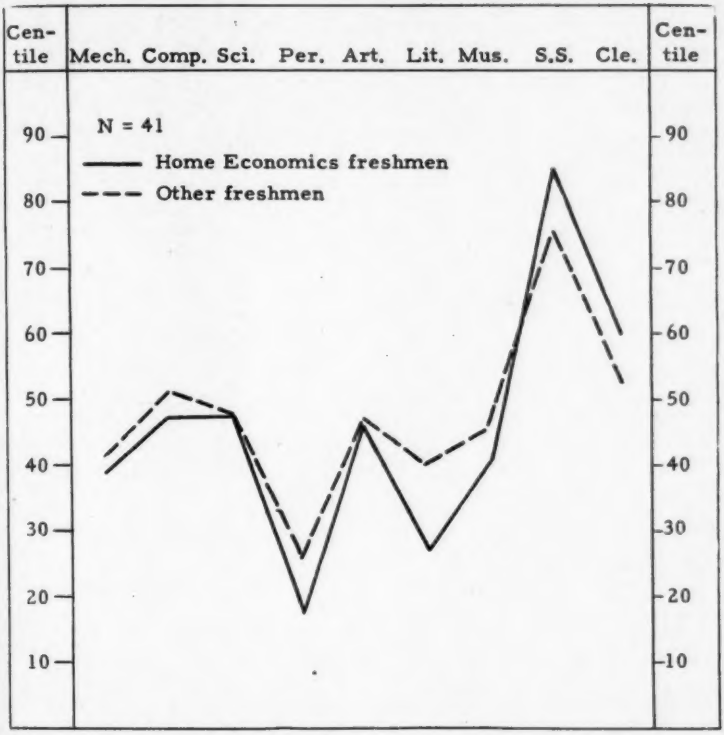

FIG. 4.—Median interests of Home Economics freshmen.

ceeds the five per cent level of significance, and it is at the one per cent level.

In Table 1 are shown a number of interesting data. In the first column is shown the distribution of interest centiles of 20 mathematics majors on the computational scale. As should be expected and desired, all are better than average. It is of course possible that one might be deeply interested and competent in mathematics without enjoying computation, for the latter is not the essence of advanced mathematics. However, it does occupy a great part of the time and effort of public school mathematics. In the second column, the rank of 10 music students on the music interest scale is shown. All of them are very high. It is also more certain that a high interest in music is required for those entering this curriculum, than it is that computational interest is necessary for mathematics majors. The third column shows the artistic interest of five art students. It is most likely that the same relation between interest and curricular choice holds here as obtains in music. We can only wonder about the person who is represented at the bottom of the scale. The English students' literary interests are depicted in the fourth column. It is

TABLE 1.—INTEREST RELATED TO PARTICULAR CURRICULA

Centile	Math. (Comp.)	Music (Music)	Art (Artistic)	English (Liter.)	Speech (Persuasive)
90–9	3	9	4	8	..
80–9	5	1	..	6	..
70–9	5	..	..	4	2
60–9	3	..	..	..	..
50–9	4	..	..	1	1
40–9	..	..	..	..	1
30–9	..	..	..	1	1
20–9	..	..	..	..	..
10–9	..	..	..	..	..
–9	..	..	1	1	1
Total	20	10	5	21	6

quite true that one may enroll in the English curriculum solely because of interest in grammar and usage for its own sake, but is doubtful if one should, since English teachers are expected to develop literary appreciation. It is further questionable whether grammar and usage should be enjoyed for their own sakes. It is possible that these students enrolled in the English curriculum have become so because of reasons totally unrelated to the subject matter of this area. Finally, in the last column is shown the persuasive interest ranks of six speech majors. Surprisingly enough there is no one with an unusually high persuasive interest. Can it be that these students have entered this curriculum because of other than forensic activities: perhaps speech correction? This is possible and we should not expect these people to have or need high persuasive interest.

In this table we have presented data which show problems of curricular choice which need further investigation. There is no clear judgment in every case as to whether students are properly or improperly placed. It is possible, however, that some of them are. Data of this kind should be studied with a view to more satisfactory curricular choice, and the possibility of making more clear to entering freshmen the bases for their choices.

In conclusion, the characteristics of the entire freshman class which are most noteworthy are the relatively high social service interest and the relatively low persuasive interest. The first of these findings is clearly in line with what is desirable. The second characteristic has a more ambiguous status. We do not know what should be expected. It is nevertheless questionable whether prospective teachers, on the average, should be so low in this respect; it seems reasonable that it would be more desirable if their average conformed to the population average.

Business education students are found to be, on the average, high in clerical and computational interest. Elementary teachers are definitely lower than other entering freshmen in literary interest. Home economics students are very similar to

other students, though they are relatively higher in social service interest.

In all these instances, there is nearly as wide a range as is found in the general college population.

Certain other curricula aside from the three just mentioned show close relationships with certain interest scales. Among these findings is evidence of individual anomalies that call for further investigation. Some of them may be of no undesirable significance, but the fact is we do not know that this is so.

Finally, studies of interest distributions and of individual interests are worthy of at least some of the attention we have given to intelligence and achievement. No one of these three aspects is sufficient of itself.

STUDY OF THE RELATIONSHIP BETWEEN CONSTITUTIONAL VARIATIONS AND FUNDAMENTAL PSYCHOTIC BEHAVIOR REACTIONS

PHYLLIS WITTMAN, WILLIAM H. SHELDON, AND CHARLES J. KATZ

This study of relationships between constitutional factors and fundamental types of psychotic behavior reaction was started at the Elgin State Hospital in June 1945.

At that time Dr. Sheldon with some associates from the University of Chicago photographed 350 male patients diagnosed by the Elgin staff as either schizophrenic, paranoid, or manic depressive.

The photographing procedure is really a standardized test situation, and the subject's ability to comprehend and to respond effectively to instruction and to assistance is measured by the resulting photographs. The placing and photographing of each subject, together with a simple measure of hand and general strength took from 3 to 5 minutes, and that is all the contact Dr. Sheldon had with any of the subjects in this study.

The somatotyping, which is a way of describing qualitatively the relative weightings for the three fundamental components of morphology, i.e., endomorphy, mesomorphy and ectomorphy, was done by Dr. Sheldon from the photographs. The ratings on temperamental pathology were made by Dr. Sheldon on the basis of the responses of each patient, as recorded at the time of photographing and as shown photographically, to the test situation already described.

The first component of temperamental pathology, corresponding to the cycloid component in the diagnostic rating, is the degree to which viscerotonia and somatotonia seem to combine maladaptively in the personality. The second component of temperamental pathology, paranoid in the diagnostic weightings, is the degree to which somatotonia and cerebrotonia seem to combine maladaptively. The third component of temperamental pathology, heboid in the diagnostic weightings, is Sheldon's evaluation of dissociative somatopenia, or failure of normal expression of somatotonia, with or without a secondarily strong cerebrotonia, and with or without a secondarily strong viscerotonia.

My part of the project included making an individual study of each patient without seeing either the photographing of the patient or the resulting picture. Each of the 167 patients worked up for this preliminary report has been evaluated on a 7-point scale as to relative strength or weakness in 221 factors of psychological and psychiatric significance.

As a final step, I recorded a quantitative evaluation of each of what we now consider to be three fundamental psychological components in psychotic behavior reactions.

1. Cycloid or affective.
2. Paranoid.
3. Heboid or regressive.

This type of evaluation was made because right from the start it was found that patients classified within a single diagnostic entity were so heterogeneous that a more elastic and discriminative diagnostic device was needed. Study of this

problem resulted in the conclusion that there may be only three fundamental components of psychotic behavior reaction, and that as far as psychotic behavior is concerned, both functional and organic cases can probably be described in terms of the relative strength of these three components (cycloid, paranoid, and heboid).

Using such a diagnostic schema made the classification of the many cases in which there was a mixture of psychotic symptoms—those diagnosed Schizo-affective psychoses, or Manic-depressive with schizophrenic features for example—clearly and easily characterizable in terms of the relative weightings of fundamental psychotic components.

To further a comparison of these diagnostic evaluations with Sheldon's components of temperamental pathology, the ratings were made on a 7-point scale with "1" indicating a complete lack, and "7" the most extreme degree of a given psychotic component.

Recognizing the subjective character of the weightings that the psychologist in the study was making we asked one of the staff physicians (C.K.) to join us in this study and evaluate independently a number of the patients on the factors studied by the psychologist.

The correlations between the two sets of weightings thus arrived at independently, but from a study of the same material for each patient, were +.89 for the cycloid factor, and +.78 for the paranoid, and +.91 for the heboid. This agreement appears not only to validify the diagnostic evaluations made by the psychologist, but also to emphasize the value and significance of a diagnosis based on a scaling of components of psychotic behavior reaction, rather than attempting to force each case into a single and specific psychiatric pigeon-hole.

One of the important questions we hoped to answer on the basis of this study was the value of morphological analysis in understanding and differentiating psychotic behavior reactions. Consequently we ran correlations between the somatotypes as determined by Sheldon and the diagnostic evaluations of the patient. Graphs were prepared which give the correlations between somatotype and diagnosis. (Slides shown in oral presentation are omitted from this preliminary report.)

The graph indicates that there is a definite relationship between body morphology and type of psychotic behavior reaction. The predominantly cycloid patients are mesomorphic endomorphs with ectopenia (lack of ectomorphy). The paranoid psychotics are strongly mesomorphic, as we had expected, but the secondarily strong ectomorphy expected did not come out. Compared to the cycloid or affective patient the paranoid is relatively ectomorphic, it is true, but in absolute values in this study he appears to be lower in ectomorphy than in endomorphy. This is possibly due to the number of affective patients with secondary strong paranoid behavior reactions. (We plan to check this finding further by study of all 350 cases, only 167 of whom are included in this preliminary report.) The heboid, i.e., regressive and hebephrenic subjects in our study, constitutionally are extreme ectomorphs and with a marked mesopenia (lack of mesomorphy).

Since Dr. Sheldon had found in other studies that the mesomorphic strength of the 3rd region (arm) was almost pathonogmonically low in heboid patients, and could be used as a diagnostic aid in such cases,

we correlated the arm mesomorphy with the weightings of the heboid component. The resulting coefficient of -.684 strongly corroborates this hypothesis.

The correlation coefficients showing the relationship between diagnosis and Sheldon's evaluations of temperament based on constitutional factors, together with the patient's reaction in the standardized photographing situation, were shown in another graph.

In the second graph the correlations are even more striking than in the first graph, suggesting that although morphology is definitely related to pattern of psychotic behavior reaction, there are other constitutional factors that are important also, and when these are taken into consideration the resultant agreement with diagnosis is remarkable.

In this kind of study it is significant that an analysis of photographs and an approach stressing constitutional factors when compared with an independent diagnostic approach stressing symptomatology should show *any* agreement at all, let alone the definite relationships we do find.

Another important point is this: That the analysis of morphology and of temperament was made by one of us; the diagnostic evaluations by a second; and the statistical analysis by Dr. French and assistants at Northwestern. *All three approaches were made independently without any knowledge of what the other collaborators in the study were finding.*

Certainly, then, these findings indicate that adequate and accurate diagnosis of psychotic patients ought to include constitutional analysis, and if this is not done the examiner is overlooking factors that have been shown to be *closely* related to psychotic behavior reaction.

As a further check on these results, and in order to gain further insight into their value, we divided the 167 subjects into 4 different categories according to the relative strength of the psychotic factors.

The affective, paranoid, and heboid groups were those whose heaviest weighting was in that type of psychotic behavior reaction. The fourth group we called mixed psychosis, since relatively equal weightings had been given to all three components of psychotic behavior reaction. This yielded 4 groups, with 31 patients classified as predominantly paranoid, 57 as hebephrenic, and 44 as mixed psychosis.

The mean strength of each primary morphological component, for each psychotic group, was computed and is given in the following table:

These data agree with the correlation results in defining the cycloid as endomorphic and mesomorphic, and low in ectomorphy; the paranoid as predominantly mesomorphic; and the heboid as predominantly ectomorphic. The mixed psychoses, including a large number of subjects diagnosed dementia praecox catatonic, and undetermined types, showed only half-step differences between the components of body build. This agrees with the hypothesis that the so-called catatonic cases are those who show affective, paranoid, and regressive features all mixed together.

Because of Dr. Sheldon's belief that shock therapy is rarely or never of value in mesopenic cases (those lacking mesomorphy in body build) we classified therapy results in three groups: much improved, temporarily improved and unimproved.

Table I indicates that as you move from the definitely improved at one extreme to the unimproved group at the other extreme, the average degree of mesomorphy decreases, and

TABLE I

	Average Somatotypes		
	Endomorphy	Mesomorphy	Ectomorphy
Psychosis Type			
Cycloid	4½	4½	2
Paranoid	3	4	3½
Heboid	3	2½	5
Mixed	3	3½	4
Shock Therapy Results			
Definite Improvement	4	4½	2
Temporary Improvement	3	4	3½
Unimproved	3	2½	4½

conversely the average degree of ectomorphy increases. We hope to check this hypothesis carefully on our therapy cases from now on whenever we are able to do constitutional analyses as a routine on newly admitted patients.

So far, I have been presenting facts and figures and throwing the terms endomorphy, mesomorphy and ectomorphy, viserotonia, somatotonia and cerebrotonia around without much compassion for those in the audience who are not acquainted with the terms. Now, however, I should like to show you a few of the photographs from which these evaluations were made (Nos. 164, 91, 47, 1, 66, in this order).

No. 164 has had 6 admissions to the Elgin State Hospital, the first in 1932, the last one in 1942. Each time he was diagnosed manic-depressive manic. He is now 44 years old. The last progress note on this patient says, "Has ground parole. Works as assistant in the morgue and takes a certain amount of responsibility well. Neat and clean, interested and cooperative. Sociable with other patients and with employees. Plays cards and is friendly, frequently conversing with others on the ward."

The patient's somatotype is $5\,4^{2}1^{2}$. The temperament rating is 5 3 2, and the diagnostic weightings are also 5 3 2; he rates 5 in affective features, 3 in paranoid, and 2 in heboid.

The massive abdomen, short thick neck, fairly broad, but well-padded shoulders, the relatively short, stubby hands, thick arms with slight hamming of the upper arm, are characteristic of the affective psychoses. The round face with fat cheeks that makes the relatively small nose seem smaller by comparison, the thick protruding lips and double chins are all there, but unfortunately in order to show the photograph the face had to be blanked out.

No. 1 is a 27-year old patient who has had three admissions to the Elgin State Hospital, diagnosed each time as dementia praecox catatonic type. He has had periods of hyperexcitability with press of speech and typical manic-like outbursts, at other times has shown the irritable, sullen, suspicious behavior characteristic of the paranoid, and frequently has had periods of extreme withdrawal,

being mute, untidy in toilet habits and appearance, extremely apathetic, and indifferent. He responds well to shock therapy, but this improvement, back to what appears to be a perfectly normal mental picture, is quite short-lived. He has had metrazol, insulin, and several courses of electric shock. The last progress note on this patient is "Definitely improved following last electric shock, but has again relapsed. Is now mute and a feeding problem." This patient's somatotype is 3 3 4 with a temperamental pathology rating of 3 3 4 and a diagnostic evaluation of 3 3 5. These evaluations of morphological, temperament and diagnostic patterns emphasize the mixed picture that we have found characteristic of the cases diagnosed catatonic. In this case the ectomorphic, cerebrotonic and heboid components predominate, thereby emphasizing the regressive features already prominently displayed.

No. 91 is a 51-year old man, a former professor of mathematics, diagnosed paranoid dementia praecox, who has been in the Elgin State Hospital for the past 20 years. The note on patient's present status is "Tidy in habits, neat in appearance, combative at times. Always superior in manner, frequently noted talking to himself. Well posted on current events, but seclusive and supercilious in contact with other patients and attendants. Eats and sleeps well."

This patient's somatotype is 2 5 3, that is to say, predominantly mesomorphic. The compact, sturdy body build with straight upright posture, relatively low waist, flat abdomen, strong muscular arms and legs, are noticeable and are especially so when this man's age, 51, and duration of psychosis (20 years) are taken into account. This patient's face and facial expression would also be revealing if you could see them. His face is the only somatotype region in which he looks his age. He has deep naso-labial folds and is heavily wrinkled. He has the firmly compressed mouth and watchful suspicious glance that, for those of us under Dr. Sheldon's tutelage, have become hallmarks of paranoid psychosis. This patient's temperament rating is 2 5 3, and his diagnostic evaluation 2 6 3. The ratings emphasize the somatorotic (pathologically somatotonic) temperament, and the paranoid psychotic behavior reaction.

Now please try to keep this patient's body build in mind to compare with the next one, who is 26 years old, as compared with this man's 51 years.

No. 66, a typical example of a severely regressed patient, was admitted to the hospital in April 1940, diagnosed dementia praecox hebephrenic. The last progress note on this patient, made a few months ago, states, "Untidy in toilet habits, very careless of personal appearance, seclusive and apathetic, has to be bathed and dressed, but infrequently will undress himself." This patient has had shock therapy, but without any improvement.

He has an extreme somatotype 117, that is to say, lacking in both endo- and mesomorphy, but with extreme ectomorphy. The excessively weak arms, the ectomorphic stoop so common in hebephrenics, the fragile pipe stem legs, all add up to the kind of physique that I am sure Dr. H. Douglas Singer was thinking of when he described what he called constitutional schizophrenia with pathologically low energy endowment.

In a previous research project in collaboration with the Child Study Bureau of the Chicago Board of

Education, we found that this particular patient had been referred when 7 years old and in the second grade to the Study Bureau because of school retardation and suspected feeble-mindedness. He was found to be of average intelligence at the Bureau, but the really significant thing is that the psychologist at that time described the 7-year-old boy as apathetic, indifferent, inattentive, timid and monosyllabic in his replies. Certainly this patient's very early pre-psychotic personality suggests the shut-in personality type that Adolph Meyer thinks characterizes schizophrenic patients just as the morphological pattern fits in with Dr. Singer's concept of constitutional schizophrenia, also fits in with Langfeld's "process" schizophrenia, and probably with Meduna and McCullough's concept of true schizophrenia as differentiated from oneirophrenia.

All this suggests that constitutional analysis can yield a definite and objective frame of reference that should be used generally in carrying out experimental projects in both diagnostic and research fields of psychiatry and abnormal psychology.

SOCIAL SCIENCE

BUILDING RURAL COMMUNITY SCHOOLS

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People in towns and cities have become greatly concerned about schools in the country areas, many because Illinois has more school units than any other state in the nation. It is fortunate, therefore, that 93 of 102 counties of the state have formed county survey committees so that farmers and small town inhabitants can study their own school conditions and make their own recommendations for school reorganization. There are powerful pressure groups in the state that know that the state legislature is the supreme school board and can pass legislation for compulsory school reorganization. So this survey effort must be done well if rural people are to build their own community schools.

Many are recognizing the need for reorganization. Some of the outstanding facts are: that the number of school age children is decreasing; farm families are getting smaller; those, especially tenant and labor families, on the poorest lands are the largest; farms are getting larger and fewer in number; and both one-room schools, as well as high schools, are too small. Studies have shown that in 1945 more than three-fourths of the one-room schools in Illinois had fewer than 15 pupils in average daily attendance. This number is below the minimum generally considered adequate to make a good school. Experience has shown that 20 to 25 pupils per teacher and at least three teachers per school are a much better and more economical number. Two-thirds of the high schools in Illinois outside of Cook County, moreover, had fewer than 150 pupils in average daily attendance in 1943-1944. This is the barest minimum needed for good and efficient high schools to provide what is generally considered by many authorities as the minimum for a good high school; seven teachers and an average of 30 pupils per teacher would require high schools with not less than 210 pupils per school.

Farmers in Illinois want to keep control of their elementary schools. Any plan of rural school reorganization should carry with it some means whereby they can retain the kind of control that will make for the best schools for rural people. A loss of the country school can mean the loss of one of the chief remaining ties in the neighborhood, which throughout the history of America has meant so much to farm people. Everything possible, therefore, should be done to preserve the neighborhood school or to build a better school in the country neighborhood as well as in the village and the town. This can be done if town and country people will work together in the reorganization of larger administrative districts. These administrative districts should be large enough to maintain a high school and as many elementary attendance units as are needed to carry through a good school program. In this way the entire school program from elementary to high school can be unified under

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one system of administration and the cost can be cut considerably if no more than the present school program is provided.

Farm people, however, want the best schools they can get. If they once understand the difference between an administrative and an attendance unit and that schools can be reorganized on a larger administrative basis now, allowing attendance units to remain as they are until conditions permit changes, then they are willing to see these kinds of changes made, especially if they see the advantages of the larger unit.

Larger community administrative units would make possible spreading the tax load more equitably over all the property. In other states it has been shown that the setting up of larger administrative units has actually reduced the cost of education. In general, however, the cost of larger administrative units and better schools is greater than the cost of smaller schools because of improved and more extensive offerings.

Any good school program, it is now recognized, should provide services in seven distinct fields: (1) A health program that provides for periodic examinations, corrective treatment, instruction and guidance in healthful living, hot lunches, adequate means to prevent and control contagious diseases, recreation, physical exercise and play suited to children. Only the larger unit can provide for this kind of a health program. (2) Every school should provide for the mastery of the basic skills, reading, writing, and arithmetic; we are discovering that this can be done best in schools which provide for larger administrative units. (3) Every school should give attention to the development of the appreciations, abilities, and the expression of the pupils through the creative arts, music, drama, painting, drawing, crafts, etc., and the larger schools can best provide these. (4) All systems should include adaptation of the school program to the especially talented or handicapped, and it is only in the larger areas that attention can be given to these. (5) Every school should provide for training for vocations, rural and urban, and the larger units are in the best position to do this. (6) The rural child needs to be given these things in terms of the environment in which he now lives as well as in terms of the environment in which he may some day live. The curriculum in the rural school should, therefore, be rural life centered. Such training cannot be given in the average one-room school as this requires properly trained teachers, library, laboratory, and similar facilities, all of which can be made available only through larger administrative units in schools financed from a larger base and with adequate state and federal aid. (7) The schools should be neighborhood and community centers, providing not only classroom, library, gymnasium, playyard, and laboratory facilities, but also facilities for community meetings, entertainment, and special group meetings, so that the school really is a community center.

Rural people of Illinois can have good rural schools if they want them. The work of the present county school survey committees can be done so that Illinois can have the most modern and effective schools that can be found anywhere in the nation. Centering upon recommending larger community administrative districts and securing the people's support of them is the first important step toward modern rural schools in Illinois.

A NEW THEORY OF POSITIVE LAW

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It may be useful to begin with an analysis of the title. The first thing to do is to deny that this theory is completely new. My own ideas about it are by now about fifteen years old and are essentially a contribution to the so called "Austrian" or "Viennese School" of a "Pure Theory of Law" which originated with H. Kelsen, now teaching at the University of California.

The next step is to limit the concept of law. This word may be used in the most general sense to denote any kind of relationship. This usage we can find in the world of being as in chemical or sociological, in mathematical or logical laws, the first two examples dealing with real, the last two with ideal objects. Some relationships in this sphere are objectively correct (as we hope), others are not, and again others were perhaps never meant to be so.

There is another group of relationships referring not to what is, the being, but to what ought to be, the "oughtness". Again laws of this kind may be objectively correct, as by definition ethical or natural laws are, or they may express only certain demands as proposals in social politics, proposed bills or for that matter mores, customary laws or statutory laws. And finally this form may be used just in a playful or joking way. To distinguish this type from the first we speak of "norms."

There is a fundamental difference between the two kinds of laws. Being may be a reality, oughtness never is. Our real behavior may of course conform to it as when we comply with a norm, but this behavior itself is not the oughtness. The latter continues to exist even if we constantly violate the norm. The norm, therefore, cannot be checked with reality, it can, however, be compared with the objectively correct ethical norm. If it conforms to it we call this particular normative law "just", otherwise "unjust". The word "theory" in the title means that this discussion will not follow the axiological line of evaluating laws according to what they ought to be but will only deal with the logical question what law is. And we shall be concerned only with normative laws from now on.

In fact we shall narrow the scope of our investigation once more to what may be called "juridical laws". Suppose we read a treatise on the sociology of property, what this institution is and what its effects are; or we may read the seventh commandment and a proposal telling us that the institution of property should be preserved, or may be that it should be abolished; finally we may read that part of Ancient Roman criminal law which deals with theft, a bill on this subject discussed in Congress, and the existing law on theft in the present day French criminal code.

We shall soon be able to distinguish between these various cases. The first case (sociology of property) deals only with what is, all the others refer to norms, the seventh commandment to an ethical norm, the proposal of a writer on social politics to the personal opinion of its author as to what ought to be. Both make demands on

human behavior but are noncommital as to what reaction should take place if the commanding norm is not complied with. It is precisely the presence of such a sanctioning norm which distinguishes the last three cases from the preceding ones. All the examples may possibly deal with the same content. It is, therefore, not the content but the formal element of combination of a commanding norm with a sanctioning norm that is characteristic of juridical law. The most general form of it would be: "A demands B, and if B does not take place and C happens D is demanded". Whatever I may substitute for the variables A, B, C, D, e.g. in order to give examples, the result will always be an element of juridical law. It may seem surprising that I can "manufacture" it that way at will. And I can actually do so but I am not yet a "law maker" because I cannot so simply "manufacture" positive law.

For not every juridical law is positive law. In the examples given before we can be rather sure that the existing French law will be called so and that the example I write down will not. There might be some dispute about the two others and probably more inclination to call the law of Ancient Rome positive than the unfinished bill in Congress. Why?

We may say that the present day French law on theft is being actualized, that is prevailingly obeyed. That does not mean that theft does not occur. It may even be very frequent so that we could not speak of a prevailing fulfillment of the commanding norm. The law, however, does not cease to be positive even in this case so long as at least the sanctioning norm is prevailingly fulfilled, that is by court action against the violation of the commanding norm.

There seems, however, to be one more requirement for positivity beside actualization (prevailing fulfillment). If I write down jokingly or just for demonstration's sake a hypothetical juridical law, it could happen that this particular demand is (by chance) fulfilled. This will probably be the case if the commanding norm demands a behavior which is usually being observed anyway, for instance certain habits and fashions as wearing straw hats from a certain date on etc. Nevertheless we would not speak of positive law because it was never meant to be taken seriously. Thus we have to add for positivity another element to actualization. Positive law must also be "given," i.e. somebody must demand it seriously. That may happen in a family if father or the older brother says: "Do it or else....." Such demand has the form of a double-norm of juridical law and if meant seriously and obeyed makes for an atmosphere of "legalism". It may be the case when a monarch or dictator or for that mateer a legislative assembly, issues laws. It is surprising but unavoidable that positivity, therefore, rests in part on a psychological element, the serious intention of the law giver. Only because in most cases there is no doubt about it, it is as a rule not mentioned explicitly. But it may play a quite important part in problems of interpretation.

This investigation has been carried on so far with respect to a single juridical norm. Very often it is not worded so plainly but its elements must be assembled from various parts of a law system, unsanctioned norms must be eliminated as merely moral appeals without juridical relevance etc. . . Now

just what is the element of coherence between the norms of a law system. They may be interdependent through "logical implication" so that the content of the lower norm B may be logically derived from the content of a higher norm A. Or the higher norm A may only point to another act of norm giving and declare what is demanded by that norm B ought to be done. This merely " functional implication" is the case of "delegation of norms". This happens for instance if father declares what mother says should be done; or if the constitution defines how ordinary laws can be made or how administrative regulations can be derived from ordinary laws; or if international law defines the conditions for the recognition of a state (and its law system) as an entity of international law.

The result is a scale of strata of laws: "Laws" agreed upon by contracting people, by-laws of associations, laws of municipalities, counties, states, federal states, the family of nations, each of them governing the legal relations, "downwards", free in its own sphere and subjected to regulations from higher strata. The result is a "pyramid" of strata of law and groups of people subjected to them. The "state" is only one group among them, theoretically not distinguished in essence from the others and not endowed originally with any quasi-mystical competence, called sovereignty. As long as it remains in the framework of international law it has only as much competence as the international law gives to its members. It is only a logical consequence that absolute sovereignty can exist only on the highest level of international law or (if there is such a thing) in groups outside of it. As far as the international law is in operation, a "world government" is already in operation. We may try to enlarge its scope but we do not have to create it. On the other hand we do not need to destroy the sovereignty of states because it is not existent, we can destroy only the erroneous belief in it.

In this way the pure theory of law may help to pave theoretically the way to the one world for which mankind is headed if it is not going to be lost.

WHEATON COMMUNITY SURVEY

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During the past two years the Division of Social Sciences at Wheaton College has been cooperating with the Wheaton Plan Commission in a study of post-war community needs. The project was undertaken at the request of the chairman of the Commission. The members of the Division welcomed the opportunity to cooperate with the Commission, both because of the historical connection of the College with the community and because the Division recognized that college growth and community expansion must be a cooperative enterprise. It also saw in this service an opportunity to acquaint the students with the needs of the community and to give to each of them some firsthand contacts with the processes of community planning. The project was, therefore, entered upon both as a community service and as a means of laboratory training for students in social science. That these aims have been realized is amply demonstrated by the response of the Plan Commission to its findings and the testimony of the students as to the values they have found in this work.

NATURE OF THE SURVEY

Conferences with the chairman of the Commission revealed the fact that information was desired on (a) population characteristics, (b) the employment habits of the people, (c) the use of present transportation facilities, (d) the degree of saturation in present housing facilities, (e) future plans in housing, employment and transportation for present residents and for those in military service, and (f) the possible "sore spots" in community facilities. Preceding studies conducted by the departments of Sociology and of Economics had revealed certain areas of needed change. A tentative schedule of data desired was then drawn up and the assistance of the National Housing Agency in Chicago was sought in formulating a questionnaire that could be readily administered by inexperienced interviewers. The experience of that agency in surveys conducted in other communities was invaluable in the preparation of the schedule ultimately adopted[1].

Plans for the survey were then formulated by a committee composed of a representative from the departments of Sociology and of Economics acting in cooperation with the Chairman of the division. Zoning and street maps of the city were used in plotting the areas to be sampled and in keeping a record of places interviewed. Volunteer surveyors from the various social science classes (sociology, economics, political science, and history) were given special instruction in interviewing and assigned to specific city blocks. Each student surveyor was supplied with mimeographed instructions and with an identification card signed by the Chairman of the Plan Commission. This card identified the student as an authorized representative of the Commission. Seniors majoring in sociology were required to participate in the interviewing and to make a study of the post-war plans of various institu-

[1] See Clemens M. Roark, "A Preliminary Guide for the Development of Local Housing Planning," 24 pages, mimeographed.

tions in the community. Others in this group were assigned to the task of preparing a map showing the growth of housing in the city by chronological periods, while still others were given the responsibility of collating and evaluating the findings of the surveyors.

Thirty-five students participated in the preparation of the first sample which covered approximately 200 families and residences. Newspaper publicity in the local paper issued by the Plan Commission preceded the interviewing.

The findings of the preliminary study were made available to the Commission in October of last year. At that time the Division was authorized to continue the study during the present year. Forty-five students have particiipated in the survey this year. The results of the interviews have not yet been collated.

Local school and municipal authorities have been very cooperative in the administration of the project. Members of the National Housing Agency have followed the work of the survey with interest. Through their suggestion, assistance has also been given to the newly created Illinois State Housing Board in setting up its plan of study for community housing needs. The Citizens Research Bureau of Chicago, a private agency, has also expressed an interest in the methods and findings of the survey.

Several of the students who worked on the survey have found the training therein valuable in securing appointments to graduate fellowships or positions with social agencies.

METHODS

The Division has sought to use those methods commonly employed by community surveyors. The basic device has been a three-page questionnaire schedule administered through a personal interview between a member of the survey group and some representative of the household. The findings recorded on these schedules have been supplemented by historical studies of population change within the community, based on a comparative study of statistical data derived from the federal decennial census with the data to be found in the federal sugar census of 1942. It has also sought to determine the historical growth of the residential areas of the community by a careful study of the expansion by time periods. This involved the preparation of a map in symbol showing the period of construction of each residence within the community. Data for such a map were gathered from a sketch map of the city made in 1882 (now in the possession of the City engineer), an air view photograph of the city made in 1906, and by a study of the building permits now on file in the City Hall. Inasmuch as the building permits were not filed prior to 1920, it was necessary to discover the residences constructed during the period 1906 to 1920 through a process of elimination. Another map is now projected to show the type of housing unit constructed in each location within the city.

FINDINGS

The findings of the survey, taken from the preliminary sample of some 200 households, revealed some interesting trends and characteristics. Some of these are in harmony with general trends; others are peculiar to this particular community.

a. *Population.* The total population of the community was found to be 9,619 in 1942 as against the 7,389 indicated by the census of 1940. The median family size was found to be

2.7 as compared with the 3.42 recorded in the census of 1930.

b. *Housing Expansion.* The greatest period of housing expansion in the community was found to have taken place during the years 1920-1929 inclusive. That decade witnessed the construction of 39.8 percent of all the housing erected within the community prior to the year 1946. The corporate area of Wheaton is almost evenly divided into a northern and southern area by the Aurora and Elgin and Chicago and Northwestern tracks. The construction of the Aurora and Elgin electric railroad to Wheaton in the early 1900's was found to have had a stimulating effect on the construction of housing in the southern portion of the city near the depot and shops of that line. During the period of 1907 to 1919 inclusive, there were 285 units constructed in that area as compared to 103 in the area north of the tracks. This was the only period wherein the south side increased more rapidly in housing facilities than the north side. The Federal Census data for housing expansion was found to be quite unreliable. The census showed 643 units constructed during the decade from 1920 to 1929, whereas, a study of building permits showed a total of 780. Allowing for some units that may not have been constructed under permits, this still shows a wide variation. Similar variations existed in other periods.

c. *Mobility of Population*: Wheaton has been thought of as a stable community. This study revealed the fact that 18 percent of the 200 families interviewed had lived in Wheaton less than two years, while 34 percent of these families had lived in Wheaton five years or less. This reflects an acceleration of movement to suburban residential areas during the period of war. Some of this turnover is undoubtedly due to the opportunities for employment in the Chicago area. The survey made no attempt to discover the reasons why persons had moved into the community in that period other than to inquire of all persons their reason for choosing Wheaton as a place of residence. Business opportunities in the Chicago area, the facilities of the College, and the residential character of the community were the reasons advanced most frequently. This turn-over in population is verified in part by the school statistics, which, the Superintendent of Schools reports, show an annual change in school population from about 30 to 33 percent.

d. *Residential Ownership.* Eighty-one percent of the households interviewed were found to be in that group which owned their own homes. This percentage may be altered by the findings of this year's study.

e. *Employment Plans and Transportation.* Investigation here showed that no substantial shift was anticipated either in employment or means of transportation used in reaching the place of employment. This was true not only of present residents, but of persons then in the service.

f. *Family Composition.* The presence of 80 children under five years of age out of a total of 255 children 19 years of age and under demonstrated the influence of the economic revival and the war upon population growth. Inasmuch as there were only 44 children in the age bracket from five to nine as compared with 78 in the bracket 10 to 14, and 53 in the bracket 15 to 19, it is reasonable to assume that there will be greater need for community facilities in the next decade to meet the needs of the rise in the birth rate in the last five years. This will be particularly true if families continue to move into the

community at the same rate as they have during the war period.

g. *Future Housing Plans.* This preliminary study revealed the fact that approximately 27 percent of all those interviewed planned some change in housing after the war. Fifty-nine percent of those planning a change were persons who already owned homes. Of this latter group 78 percent were contemplating new construction. Future building plans called for homes costing from $6,000 and up with the greatest frequency of demand in the $10,000 to $12,000 bracket. Houses providing three bedrooms were most frequently projected, with houses providing four bedrooms and two bedrooms proposed in that order of declining frequency. Should these same frequencies appear in the completed study, it would mean that there would be a potential market for at least 540 dwelling units from present residents in the community following the war. Forty percent of these units would be provided through new construction, thus releasing a similar proportion to those desiring to purchase homes and leaving approximately 20 percent to be provided through other channels. Inasmuch as most of the projected housing calls for the construction of the larger and more expensive type of unit, it is quite possible that either private contractors or public agencies must step in to meet the low-cost housing needs of the present Wheaton population. This estimate makes no provision for the natural expansion of population in the community.

h. *Community Services.* Two devices were used on the questionnaire to discover inadequacies in community services. One was to secure an expression from the one interviewed concerning the type of community service wherein he was inconvenienced. He was permitted to express "no inconvenience," "some inconvenience," or "very much inconvenience." On the basis of this type of expression, the chief areas of community need were found to be in (a) lack of adequate parking facilities, (b) lack of adequate recreational facilities for elementary and high school students, (c) lack of hospital facilities and adequate medical services, and (d) absence of adequate and reasonable housing.

Another device used was to ask the one interviewed to give an answer to this question: "Of all the things which might be done to make Wheaton a better city in which to live, what would you rank as most important?" Most frequent replies referred to better housing in the form of smaller houses and apartments, the need of a hospital, the need of guidance and recreation for the high school group, the need of enforcing the zoning laws, and the necessity of constructing a railroad underpass.

From these preliminary findings, it seems clear that the responsibility of the Plan Commission will center around the following community needs: (1) the construction of reasonably-priced housing facilities of the apartment type; (2) the construction of a hospital; (3) the provision of additional parking space in the shopping area; (4) the provision of additional community recreational facilities for the secondary school group; (5) the elimination of surface transportation hazards through the construction of railroad underpasses at convenient places in the downtown area. It is conceivable that if these needs are met, some of the other areas of friction, such as the need of additional medical facilities and the need for enforcing the zoning laws, together with the inadequacy of the shopping area, might be gradually eliminated.

ZOOLOGY

STUDIES ON CERTAIN FILTRABLE VIRUSES

IX. ANTIGENIC PROPERTIES OF UNDESICCATED ENTIRE EMBRYO FOWL POX VIRUS IN BUFFERED GLYCERINE

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In a previous report the results of immunization of susceptible chickens with fowl-pox vaccine prepared from the entire chicken embryo, desiccated and suspended in various diluents was reported by Kerlin and Graham (1). Brandly and Dunlap (2) previously demonstrated the immunizing properties of fowl-pox-virus material prepared from the pox skin lesions and also from the chorioallantoic membranes of inoculated embryos showing typical fowl-pox lesions.

These three forms of the virus, after desiccation, are stored in sterile vials at –4°C. Immediately prior to field use the triturated virus material is suspended in distilled water, physiological saline, mineral oil or other suitable diluent.

Since the viability and immunizing properties of desiccated entire embryo virus suspended in various diluents have been demonstrated under laboratory and field conditions, experimental inquiry into the viability as well as the immunizing properties of the undesiccated entire embryo virus was inaugurated. It is the purpose of this paper to report the results of this study.

PREPARATION OF THE ENTIRE EMBRYO VIRUS

A desiccated, chorioallantoic virus stored at –4C° was the source of the virus used in this study. A 1:100 tryptone broth suspension of the chorioallantoic fowl-pox virus was inoculated onto the chorioallantoic membrane of ten to twelve day old developing chicken embryos by a modification of Burnet's technique (3). After five days further incubation at 37°C, the shells were swabbed with colloidal iodine and the chorioallantoic membrane of each egg was carefully examined for characteristic fowl-pox lesions. Membranes showing characteristic lesions together with the entire embryos were harvested aseptically by removing the contents of the eggs into sterile Petri dishes. The harvested entire embryos were immediately pooled, transferred to an electric tissue grinder and homogenized to the consistency of thick cream. The homogenized embryos were placed in sterile flasks and either used immediately in vaccine preparation or stored at –4°C, until needed.

PREPARATION OF THE BUFFERED GLYCERINE DILUENT

The only diluent employed in this experiment was a sterile 50 percent suspension of buffered glycerine in distilled water. The diluent was prepared by suspending 375 cc. of glycerine (C.P.) and 1.62 grams anhydrous potassium dihydrogen phosphate in 375 cc. of distilled water.

Sodium hydroxide was used to adjust to pH 7.6. The diluent was sterilized for 45 minutes under 15 pounds steam pressure.

PREPARATION OF THE VACCINE

The undesiccated, entire-embryo, fowl-pox-virus material was added directly to the diluent and suspended by gentle shaking. The virus material was readily suspended and miscible. For field use the vaccine consisted of a 5 percent suspension of the virus material in the buffered glycerine diluent. The prepared vaccine was stored at –4°C. and dispensed in screw capped vaccine bottles. One lot of vaccine was prepared for this investigation. The viability of the vaccine was checked monthly by the feather follicle method of inoculation of susceptible chickens. Viability tests proved the vaccine capable of producing take reactions during a four-month storage period at –4°C.

INOCULATION OF FLOCKS WITH THE VACCINE

A healthy flock of 2475 chickens was vaccinated by the three-stick inoculation method into the patagium of the wing in June 1945. Observations of over 10 per cent of the birds seven days after inoculation revealed positive take reactions in 97.9 percent. No ill effects were noted in the birds after inoculation with the vaccine. Ninety days after vaccinating, ten chickens from this flock were artificially exposed to viable fowl-pox virus. None of the ten showed a reaction to this exposure.

The experimental vaccine was supplied to several veterinarians and flock owners throughout the state of Illinois for experimental field use on farm flocks, with directions for application and interpretation of results. A total of 17 flocks including 23,282 birds, of which 7,087 were turkeys, were vaccinated by the stick method by eleven different field vaccinators. Take reactions reported in the various flocks varied from 25.4 percent to 100 percent (Table 1).

It was estimated that 18,899 of the 23,282 birds vaccinated developed take reactions, and that 4,383 birds did not develop takes. The overall estimate of the number of birds vaccinated in the field, either by veter-

TABLE 1.—FIELD RESULTS OF BIRDS VACCINATED WITH UNDESICCATED ENTIRE EMBRYO FOWL POX VACCINE

Group Numbers	Birds vaccinated	Percent takes reported
1 (3 flocks)	3800*	100.0
2 (1 flock)	1014	100.0
3 (1 flock)	2700	95.0
4 (1 flock)	4087*	95.0
5 (1 flock)	353	95.1
6 (1 flock)	235	99.0
7 (5 flocks)	8600*	67.5
8 (1 flock)	653	60.0
9 (1 flock)	342	61.0
10 (1 flock)	766	25.4
11 (1 flock)	732	66.0
	23,282	

* Turkeys included in groups 1, 4, and 7.

inarians or flock owners, and developing positive take reactions was 81.17 percent.

DISCUSSION

The undesiccated, entire-embryo, fowl-pox virus when suspended in buffered glycerine induced a high percentage of take reactions in susceptible chickens in the laboratory and in a flock of 2475 chickens when inoculations were made and takes were read by experienced handlers of fowl-pox vaccine. The vaccination of farm flocks by fowl-pox vaccinators, which in some cases had had less experince, resulted in a slightly lower percentage of take reactions. The possibility that certain of the farm flocks had been exposed to fowl-pox before the time of vaccination was not determined. However, it seems reasonable to expect that such a condition could have occurred in flocks where take reactions were low. The possibility of faulty technique having been used in inoculating birds or in reading take reactions could not be excluded. The results of farm flock vaccinations included in this report, suggest that proper care of the vaccine in the field, proper vaccinating technique, and a flock history are all essential in the establishment of a satisfactory fowl-pox vaccinating program.

SUMMARY

Results of the immunizing properties of an experimental fowl-pox vaccine, prepared from undesiccated, entire-embryo, fowl-pox-virus material suspended in a buffered glycerine diluent, is reported. A 5 percent suspension of undesiccated virus material was readily miscible and remained in suspension well in the diluent. The vaccine proved potent during a four-month storage period when held at –4°C. A flock of 2475 chickens inoculated by the three-stick method with the vaccine resulted in 97.9 percent of the birds showing positive take reactions. Field vaccination of farm flocks by veterinarians and flock owners resulted in take reactions in 81.17 percent of 23,282 birds, which included 7,087 turkeys. Factors essential in operating a satisfactory fowl-pox vaccinating program such as proper care of the dispensed vaccine, proper vaccinating technique, and the importance of a flock history are also discussed.

REFERENCES

1. Kerlin, D. L. and Graham, R.: Studies on Certain Filtrable Viruses VIII. Viability of Chicken Embryo Fowl Pox Virus. Am. J. of Vet. Res., 6. (1945): 204-207.
2. Brandly, C. A., and Dunlap, G. L.: Studies on Certain Filtrable Viruses II. Immunization Against Fowl Pox with Fowl- and Pigeon-pox Viruses Cultivated in Vivo and in Vitro. J.A.V.M.A., 95, (1939): 340-349.
3. Burnet, F. M.: The Use of the Developing Egg in Virus Research. Med. Res. Council (Gt. Brit.), Spec. Rept. Ser. No. 220, 1936.

EXPERIMENTAL WORK WITH DDT ON APPLES IN ILLINOIS, 1945

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Illinois State Natural History Survey

Experimental work on apples was designed primarly to study the control of codling moth, but observations were also made on the effect of DDT on other insects and on mites.

DDT (dichloro-diphenyl-trichloroethane) was used at the rate of 1 pound of the actual material (50, 60, and 75 percent inert ingredients in the compounds used) to 100 gallons of water with no other poison, and at ¼ pound or ½ pound with 2 pounds of lead arsenate or with half-normal strength of fixed nicotine. Summer oil at 2 quarts per 100 gallons was used as a sticker and an ovicide. In some of the tests a weak Bordeaux was used as a safener for the lead arsenate where used in combination with lead arsenate.

Tests were conducted in 11 orchards in the following counties: Johnson, Jackson, St. Clair, Jefferson, Jersey, Calhoun, Pike, Adams, and Champaign. The final infestation data from all but the last one are given in Table 1. As will be seen from this table, DDT was used in comparison with blocks sprayed with lead arsenate or nicotine or both. In these standard blocks, lead arsenate was used at 4 pounds to 100 gallons in most applications. Nicotine in the standard blocks was either a commercially prepared fixed nicotine called Black Leaf 155, used generally at 3 pounds per 100 gallons, or a tank-mixed fixed nicotine in which 1 pint of nicotine sulfate is "fixed" with 8 pounds of Mississippi bentonite and 2 quarts of summer oil.

The number of applications varied somewhat in each plot. In general it was the plan to spray as many times in one plot as another, but in several instances the DDT plots received one or two fewer applications than the standard, yet as seen in the table, in every test the DDT plots were superior to the standard plots. The total number of sprays ranged from 8 to 15, depending on the general level of infestation and the schedule used in the orchard by the owner. However, in every orchard there were fewer DDT sprays than standard sprays because DDT was not started until the calyx spray of lead arsenate and two or three applications of standard materials had been applied to all plots. This was done because, for certain reasons, it is not considered advisable to use DDT continuously from first to last in the spray schedule on apples.

Partly counterbalancing the excellent control of codling moth obtained in these tests, certain disadvantages of the use of DDT on apples were brought out. The most general and obvious disadvantages were the injury from use of the combination of DDT and summer oil and the increase in red spiders and mites. Minor disadvantages were greener color of fruit at harvest and greater degree of russeting in a few instances.

The oil-DDT injury was quite general except on certain resistant varieties, and began after the third or fourth application of the DDT and oil. The resistant varieties which showed practically no injury

FIG. 1.—Spraying in DDT plots.

were Winesap, Stayman, York, and Maiden Blush. Tests are under way to determine the need for summer oil with DDT, the amounts needed, and a safener for the oil, and this problem may be worked out.

Red spiders and mites were found to increase in DDT plots because parasites and predators are reduced to a greater extent by DDT than are the hosts. Mites have never been much of a problem in Illinois apple orchards until the advent of DDT. The inclusion of DDT in our spray schedules will result in much study on the activities and control of these pests.

CONCLUSIONS

1. Control of codling moth and leafhopper was always better in DDT blocks than in the standard blocks used as a comparison, regardless of the fact that in some tests fewer applications of DDT were used.

2. There was considerable evidence to show that DDT with summer oil can be used at less frequent intervals than the standard materials or that the spray schedule of the season may be shortened where DDT is used.

3. The combination of ¼ and ½ pound of DDT per 100 gallons with half strength lead arsenate or nicotine gave about as good control as 1 pound DDT alone.

4. Of these two combinations, the lead arsenate with DDT was somewhat more effective than the DDT-nicotine combination.

5. There was no significant difference in control with the various brands of DDT used.

6. DDT, as we used it with summer oil for several applications, caused injury somewhat in proportion to the amount of DDT used, being less severe in plots in which combinations of small amounts of DDT with lead arsenate or nicotine were used.

7. Mite injury was moderate to severe in all DDT plots, being less

severe in plots in which the smaller dosages were used.

8. In the 11 orchards in which these tests were conducted, there were 3 in which the fruit was greener at harvest in the DDT blocks than in the standard, 2 in which it was smaller, and 3 in which it was more russeted.

These studies will be continued by the Natural History Survey for the coming season.

TABLE 1.—FINAL INFESTION RECORDS ON PICKED FRUIT IN DDT EXPERIMENTAL PLOTS IN ILLINOIS, 1945

Orchard	Plot No.	Materials Used Chiefly In Spray Schedule Amounts per 100 gal.	Percent Wormy Apples	Worms Per 100 Apples	Percent Stung Apples	Stings Per 100 Apples
Smith	1	DDT 1 lb.[1]	1.0	.....	1.6	.....
	2	DDT ½ lb. Lead Arsenate	.4	.....	1.4	.....
	3	Lead Arsenate	13.0	.....	10.7	.....
	4	Lead Arsenate, one DDT	16.1	.....	11.5	.....
Sauer	1	DDT 1 lb.	1.0	1.0	2.8	3.2
	2	DDT ¼ lb. Lead Ars. 2 lb.	6.6	9.0	5.9	8.7
	3	BL 155	2.4	2.7	3.5	4.7
	4	DDT with nicotine	9.2	11.4	7.9	10.1
	5	Lead Arsenate	4.0	5.1	11.9	16.7
Eckert	1	DDT	0	.....	0	.....
Duchess	2	Tank mixed nicotine	.4	.....	.7	.....
Wealthy	1	DDT	.1	.....	.3	.....
		Nicotine, tank mix	.5	.....	.5	.....
Jonathan	1	DDT	3.4	.....	2.6	.....
	2	Nicotine, tank mix	16.4	.....	7.0	.....
Gage-	1	Lead Arsenate, nicotine	2.2	.....	6.6	.....
Hawkins	2	DDT 1 lb.	0	.....	.5	.....
Nugent and	1	BL 155	11.8	18.3	5.3	7.6
Schapanski	2	DDT (Dupont) 1 lb.	2.6	2.7	2.2	2.4
	3	DDT (Dupont) ¼ lb. Lead 2	2.4	2.5	3.4	5.0
	4	HE 761–late Z39 and Lead	68.3	180.9	11.1	62.5
	5	Z39 ½ lb. Lead 2	59.7	152.3	10.6	50.3
	6	DDT with nicotine	11.0	15.9	5.4	5.8
	7	DDT (Geigy) 1 lb.	3.6	3.9	4.8	4.8
	8	DDT (Geigy) ¼ lb. Lead 2	4.8	6.1	3.2	3.5
	9	Lead Arsenate	19.2	29.0	19.5	44.2
	10	Lead Nicotine split	12.8	16.4	18.4	37.5
	Check	None treatment	92.0	247.0	6.0	19.8
Ringhausen	1	Lead Arsenate	2.4	.....	9.5	.....
	2	DDT 1 lb.	.1	.....	1.4	.....
Coffman	1	Lead-nicotine split	7.6	.....	14.0	.....
		DDT 1 lb. from 5th cover	4.0	.....	5.0	.....
Veihl	1	Lead Arsenate, nicotine	.7	.....	2.0	.....
	2	DDT ½ lb. Lead 2	0	.....	0	.....
Chatten	1	Lead Arsenate	3.0	.....	12.0	.....
	2	DDT ½ lb. BL 155	0	.....	0	.....
Thornton	1	Lead Arsenate, nicotine split	45.2	.....	21.8	.....
	2	DDT 1 lb.	3.6	.....	5.4	.....
	3	DDT ½ lb. Lead 2	7.2	.....	15.0	.....

[1] DDT amounts given are actual DDT.

CHECK LIST OF THE BIRDS OF STARVED ROCK STATE PARK AND SURROUNDING TERRITORY

DONALD T. RIES, *Normal, Ill.* AND FLOYD G. WERNER, *Ottawa, Ill.*

The following is a list of the birds observed in Starved Rock State Park, LaSalle County, Illinois and the immediately surrounding territory. A total of 212 species is recorded.

The arrangement of the list is based on the fourth A. O. U. check-list.

This list has been made up from observations made by the authors, as well as by Frank Bellrose and Arthur Hawkins of the Illinois State Natural History Survey, Urbana, Illinois, and Charles J. Alikonis, Ottawa Township High School, Ottawa, Illinois.

Notations are made as to the frequency with which the birds have been observed and the time of year; *viz.* Common Loon, a migrant—designates that this bird is seen occasionally during spring and fall migrations.

GAVIIDAE—LOONS

Common Loon—*(Gavia immer immer)*
A migrant. Never very common.

COLYMBIDAE—GREBES

Horned Grebe—*(Colymbus auritus)*
Scarce during migration. Frequents sloughs and other still waters.

Pied-billed Grebe—*(Podilymbus podiceps podiceps)*
The "Hell-diver". Fairly common during migration, in the same habitats as the former.

PHALACROCORACIDAE—CORMORANTS

Double-crested Cormorant—*(Phalacrocorax auritus auritus)*
Scarce summer resident, becoming common during migration. Best known as the "Nigger Goose".

ARDEIDAE—HERONS and BITTERNS

Great Blue Heron—*(Ardea herodias herodias)*
Fairly common summer resident. Nests in tall trees on islands in the Illinois River.

American Egret—*(Casmerodius albus egretta)*
Common in the fall. The individuals that reach us are young birds that wander north after they have left the nest.

Little Blue Heron—*(Florida caerulea caerulea)*
Scarce summer resident and migrant.

Eastern Green Heron—*(Butorides virescens virescens)*
Fairly common summer resident. Common along Illinois and Michigan Canal State Park.

Black-crowned Night Heron—*(Nycticorax nycticorax hoactli)*
Common summer resident. Nests in low trees in the Illinois River valley.

American Bittern—*(Botaurus lentiginosus)*
Scarce migrant. More common than usually supposed as it is a frequenter of deep cat-tail marshes.

Eastern Least Bittern—*(Ixobrychus exilis exilis)*
Occasionally found in the cat-tail marshes.

ANSERINAE—GEESE

Canada Goose—*(Branta canadensis canadensis)*
Frequent during migration. Often seen flying high overhead but only rarely alighting on the river.

American Brant—*(Branta bernicla hrota)*
A scarce migrant.

ANATINAE—SURFACE-FEEDING DUCKS

Mallard—*(Anas platyrhynchos platyrhynchos)*
Fairly common summer resident, nesting here. In January and February large flocks occur in the Illinois valley, often going out into corn fields to feed.

Red-legged Black Duck—*(Anas rubripes rubripes)*
This and the next occur in flocks intermingling with the Mallard in winter. This subspecies is more common here.

Common Black Duck—*(Anas rubripes tristis)*

Somewhat scarcer than the former, often occurring in the same flocks.

Gadwall—(*Chaulelasmus streperus*)
A scarce migrant.

Baldpate—(*Mareca americana*)
Scarce migrant of early fall.

Pintail—(*Dafila acuta tzitzihoa*)
Scarce migrant in the late fall and early spring.

Green-winged Teal—(*Nettion carolinense*)
Scarce early fall migrant.

Blue-winged Teal—(*Querquedula discors*)
Fairly common early fall migrant. Frequent summer resident.

Shoveller—(*Spatula clypeata*)
Common in early fall, on shallow, still water.

Wood Duck—(*Aix sponso*)
Quite common during migration some years. Also a frequent summer resident.

NYROCINAE—DIVING DUCKS

Redhead—(*Nyroca americana*)
Frequent migrant. Seen among the huge flocks of Lesser Scaups along the Illinois River.

Ring-necked Duck—(*Nyroca collaris*)
Frequent migrant. Here at the same time as the Lesser Scaup, but segregated, nearer shore.

Canvas-back—(*Nyroca valisineria*)
Once rare. Now frequent during migration.

Lesser Scaup Duck—(*Nyroca affinis*)
Our most common duck. During migration present in thousands. A few nesting here in the summer. The "Bluebill".

American Golden-eye—(*Glaucionetta clangula americana*)
In small flocks during migration. Often in faster water than the other ducks. The "Whistler".

Buffle-head—(*Charitonella albeola*)
"Butterball." Now rather scarce, during migration.

Old Squaw—(*Clangula hyemalis*)
Apparently a rare migrant. One specimen taken by a hunter.

White-winged Scoter—(*Melanitta deglandi*)
Also rare, with a single specimen represented, shot by a hunter.

ERISMATURINAE—RUDDY and MASKED DUCKS

Ruddy Duck—(*Erismatura jamaicensis rubida*)
Frequent in the fall, along banks of the Illinois River. Rarely shot by hunters as it leaves before the duck season opens.

MERGINAE—MERGANSERS

Hooded Merganser—(*Lophodytes cucullatus*)
Frequent in sloughs during migration.

American Merganser—(*Mergus merganser americanus*)
In small flocks on open water during migration.

Red-breasted Merganser—(*Mergus serrator*)
A scarce migrant.

ACCIPITRIINAE—SHORT-WINGED HAWKS

Sharp-shinned Hawk—(*Accipiter velox*)
One of the more common hawks. Permanent resident.

Cooper's Hawk—(*Accipiter cooperi*)
Permanent resident. Quite scarce.

BUTEONINAE—BUZZARD HAWKS

Eastern Red-tailed Hawk—(*Buteo borealis borealis*)
A very scarce permanent resident.

Northern Red-shouldered Hawk—(*Buteo lineatus lineatus*)
Scarce permanent resident.

American Rough-legged Hawk—(*Buteo lagopus johannis*)
Frequent permanent resident.

Southern Bald Eagle—(*Haliaeetus leucocephalus leucocephalus*)
Once frequently seen but now almost extinct in this region.

CIRCINAE—HARRIERS

Marsh Hawk—(*Circus hudsonius*)
Our second most common hawk, over marshes and fields.

PANDIONINAE—OSPREYS

Osprey—(*Pandion haliaetus carolinensis*)
Frequent migrant along the Illinois River.

FALCONIDAE—FALCONS

Eastern Sparrow Hawk—(*Falco sparverius sparverius*)
Our most common hawk. Seen along roads, etc.

TETRAONIDAE—GROUSE

Greater Prairie Chicken—(*Tympanuchus cupido americanus*)
A species stocked here. Rare.

PERDICIDAE—PARTRIDGE

Eastern Bob-white—(*Colinus virginianus virginianus*)
Permanent resident, fairly common. Nests in upland fields and thickets.

PHASIANIDAE—PHEASANTS

Ring-necked Pheasant—*(Phasianus colchicus colchicus)*
Introduced. Scarce permanent resident.

RALLIDAE—RAILS, GALLINULES, COOTS

King Rail—*(Rallus elegans elegans)*
Summer resident and migrant. In deep marshes and rarely seen.

Virginia Rail—*(Rallus limicola limicola)*
Scarce migrant of the deep marshes.

Sora—*(Porzana carolina)*
Common for a short period in the spring and fall.

Coot—*(Fulica americana)*
"Mudhen." A common migrant.

CHARADRIIDAE—PLOVERS and TURNSTONES

Semipalmated Plover—*(Charadrius semipalmatus)*
Scarce migrant of mud flats.

Killdeer—*(Oxyechus vociferus vociferus)*
Frequent summer resident.

Golden Plover—*(Pluvialis dominica dominica)*
A rare migrant.

SCOLOPACIDAE—SNIPE, SANDPIPERS, etc.

Woodcock—*(Philohela minor)*
Frequent summer resident.

Wilson's Snipe—*(Capella delicata)*
Late spring and early fall migrant. Common when it occurs.

Upland Plover—*(Bartramia longicauda)*
Frequent summer resident, along roads.

Spotted Sandpiper—*(Actitis macularia)*
"Tip-up." Common migrant and scarce summer resident.

Eastern Solitary Sandpiper—*(Tringa solitaris solitaris)*
Quite common on mud flats and along shores during migration.

Greater Yellow-legs—*(Totanus melanoleucus)*
Fairly common migrant. Occurs on mud flats with the following.

Lesser Yellow-legs—*(Totanus Flavipes)*
Fairly common migrant.

Pectoral Sandpiper—*(Pisobia melanotos)*
Fairly common migrant. Along shores.

Least Sandpiper—*(Pisobia minutilla)*
This and the following are hard to separate. Scarce. Migrant.

Semipalmated Sandpiper—*(Ereunetes pusillus)*
Scarce migrant. Observed along mud flats.

LARINAE—GULLS

Herring Gull—*(Larus argentatus argentatus)*
Common, but not as common as the following. Present most of the year but much more common in the winter.

Ring-billed Gull—*(Larus delawarensis)*
Our most common gull at all times. Occurs with the former.

Bonaparte's Gull—*(Larus philadelphicus)*
A scarce migrant.

STERNINAE—TERNS

Common Tern—*(Sterna hirundo hirundo)*
A frequent migrant.

Caspian Tern—*(Hydroprogne caspia imperator)*
A quite scarce migrant.

Black Tern—*(Chlidonias nigra surinamensis)*
A common migrant, passing up and down the Illinois River in large flocks.

COLUMBIDAE—PIGEONS and DOVES

Eastern Mourning Dove—*(Zenaidura macroura carolinensis)*
A common permanent resident.

CUCULIDAE—CUCKOOS and ANIS

Yellow-billed Cuckoo—*(Coccyzus americanus americanus)*
Frequent summer resident.

Black-billed Cuckoo—*(Coccyzus erythrophthalmus)*
A scarce summer resident.

TYTONIDAE—OWLS (in part)

Barn Owl—*(Tyto alba pratincola)*
Rare. Single pair nesting along Illinois River 8 mi. west of Ottawa.

Eastern Screech Owl—*(Otus asio naevius)*
Common permanent resident.

Great Horned Owl—*(Bubo virginianus virginianus)*
Frequent permanent resident.

Montana Horned Owl—*(Bubo virginianus occidentalis)*
Record based on a single specimen brought in to the Ottawa Township High School.

STRIGIDAE—OWLS (in part)

Northern Barred Owl—*(Strix varia varia)*
Several nesting along the cliffs of Starved Rock State Park.

Long-eared Owl—(*Asio wilsonianus*)
Only one specimen seen.

Short-eared Owl—*(Asio flammeus flammeus)*
Fairly common. Seen in daytime over marshes.

CAPRIMULGIDAE—GOATSUCKERS

Eastern Whip-poor-will—*(Antrostomus vociferus vociferus)*
Frequent summer resident in suitable places.

Eastern Nighthawk—(*Chordeiles minor minor)*
Common summer resident, especially in cities, where it nests on pebbled roofs.

MICROPODIDAE—SWIFTS

Chimney Swift—*(Chaetura pelagica)*
Common summer resident.

TROCHILIDAE—HUMMINGBIRDS

Ruby-throated Hummingbird—*(Archilochus colubris)*
Quite common summer resident and early fall or late summer migrant, coming through when the *Impatiens* are in bloom.

ALCEDINIDAE—KINGFISHERS

Eastern Belted Kingfisher—*(Megaceryle alcyon alcyon)*
Common in summer. A few sometimes stay all winter, near places where the water is open. The mallards and black ducks often keep patches of water open. In these the kingfisher does his fishing when the ducks are feeding in the fields.

PICIDAE—WOODPECKERS

Northern Flicker—*(Colaptes auratus luteus)*
Common summer resident.

Red-bellied Woodpecker—*(Centurus carolinus)*
A permanent resident.

Red-headed Woodpecker—*(Melanerpes erythrocephalus)*
A common summer resident.

Yellow-bellied Sapsucker—*(Sphyrapicus varius varius)*
Common migrant in early spring and late fall.

Eastern Hairy Woodpecker—*(Dryobates villosus villosus)*
Scarce permanent resident.

Northern Downy Woodpecker—*(Dryobates pubescens medianus)*
Common permanent resident.

Artic Three-toed Woodpecker—*(Picoides arcticus)*
A rare winter visitor from the north.

TYRANNIDAE—FLYCATCHERS and KINGBIRDS

Eastern Kingbird—(*Tyrannus tyrannus)*
A common summer resident.

Northern Crested Flycatcher—*(Myiarchus crinitus boreus)*
A common summer resident.

Eastern Phoebe—*(Sayornis phoebe)*
Frequent in canyons from early spring to late fall.

Yellow-bellied Flycatcher—*(Empidonax flaviventris)*
Frequent migrant, occurring on the uplands.

Acadian Flycatcher—*(Empidonax virescens)*
Rare migrant.

Alder Flycatcher—*(Empidonax trailli trailli)*
Rare migrant.

Least Flycatcher—*(Empidonax minimus)*
Rare migrant.

Eastern Wood Pewee—*(Myiochanes virens)*
Common in upland woods throughout the summer.

Olive-sided Flycatcher—*(Nutallornis mesoleucus)*
Frequent migrant in the uplands.

ALAUDIDAE—LARKS

Prairie Horned Lark—*(Otocoris alpestris praticola)*
Common in the upland fields in winter. A scarce summer resident. The Northern Horned Lark may be the form in the winter but we have not been able to distinguish between the two.

HIRUNDINIDAE—SWALLOWS

Tree Swallow—*(Iridoprocne bicolor)*
Common in summer. Nests in trees over water.

Bank Swallow—*(Riparia riparia riparia)*
Summer resident. Nests along cliffs.

Rough-winged Swallow—*(Stelgidopteryx ruficollis serripennis)*
Common. Nests in cliffs also.

Barn Swallow—*(Hirundo erythrogaster)*
Frequent summer resident, near barns.

Northern Cliff Swallow—*(Petrochelidon albifrons)*
Common in certain places. Nests along cliffs or under bridges.
Purple Martin—*(Progne subis subis)*
Common. Rarely found nesting except in the boxes provided for their use.

CORVIDAE—JAYS and CROWS
Northern Blue Jay—*(Cyanocitta cristata cristata)*
Common permanent resident.
Eastern Crow—*(Corvus brachyrhynchos brachyrhynchos)*
Common permanent resident.

PARIDAE—CHICKADEES and TITMICE
Black-capped Chickadee—*(Penthestes atricapillus atricapillus)*
Common permanent resident.
Tufted Titmouse—*(Baeolophus bicolor)*
Frequent permanent resident.

SITTIDAE—NUTHATCHES
Northern White-breasted Nuthatch—*(Sitta carolinensis carolinensis)*
Fairly common all year.
Red-breasted Nuthatch—*(Sitta canadensis)*
A scarce migrant.

CERTHIIDAE—BROWN CREEPER
Brown Creeper—*(Certhia familiaris americana)*
Frequent permanent resident.

TROGLODYTIDAE—WRENS
Eastern House Wren—*(Troglodytes aedon aedon)*
Common summer resident.
Eastern Winter Wren—*(Nannus hiemalis hiemalis)*
Frequent in winter.
Bewicks Wren—*(Thryomanes bewicki bewicki)*
Scarce summer resident.
Carolina Wren—*(Thryothorus ludovicianus ludovicianus)*
Fairly common permanent resident.
Prairie Marsh Wren—*(Telmatodytes palustris palustris)*
Frequent summer resident in cat-tail marshes.
Short-billed Marsh Wren—*(Cistothoris stellaris)*
Scarce migrant in cat-tail marshes.

MIMIDAE—MOCKERS
Catbird—*(Dumatella carolinensis)*
Common summer resident.
Brown Thrasher—*(Toxostoma rufum)*
Quite common summer resident.

TURDIDAE—THRUSHES
Eastern Robin—*(Turdus migratorius migratorius)*
Common summer resident. Sometimes a few stay all winter.
Wood Thrush—*(Hylocichla mustelina)*
Frequent summer resident. Often heard in the Park.
Eastern Hermit Thrush—*(Hylocichla gattata faxoni)*
Common migrant of early spring.
Olive-backed Thrush—*(Hylocichla ustalata swainsoni)*
Common late migrant.
Gray-cheeked Thrush—*(Hylocichla minima)*
Common late migrant.
Veery—*(Hylocichla fuscescens fuscescens)*
Rare migrant.
Eastern Bluebird—*(Sialia sialis sialis)*
Common migrant and frequent summer resident.

SYLVIIDAE—GNATCATCHERS and KINGLETS
Blue-Gray Gnatcatcher — *(Polioptila caerulea caerulea)*
Frequent migrant and summer resident.
Eastern Golden-crowned Kinglet—*(Regulus satrapa satrapa)*
Common in migration and frequent in winter.
Eastern Ruby-crowned Kinglet—*(Corthylio calendula calendula)*
Same as the former.

BOMBYCILLIDAE—WAXWINGS
Bohemian Waxwing—*(Bombycilla garrula pallidiceps)*
Rare migrant. Occurs in flocks of the following.
Cedar Waxwing—*(Bombycilla cedrorum)*
Frequent migrant but erratic in its appearance.

LANIIDAE—SHRIKES
Northern Shrike—*(Lanius borealis)*
Scarce migrant.
Migrant Shrike—*(Lanius ludovicianus migrans)*
Common migrant and frequent summer resident. The "butcher-bird".

STURNIDAE—STARLINGS
Starling—*(Sturnus vulgaris)*
Common permanent resident.

VIREONIDAE—VIREOS
Yellow-throated Vireo—*(Vireo flavifrons)*
Frequent migrant.

Blue-headed Vireo—*(Vireo solitarius solitarius)*
Scarce migrant.
Red-eyed Vireo—*(Vireo olivaceus)*
Common migrant and frequent summer resident.
Eastern Warbling Vireo—*(Vireo gilvus)*
Frequent to common summer resident.

COMPSOTHLYPIDAE—WOOD WARBLERS

Black and White Warbler—*(Mniotilta varia)*
One of the commoner warblers during migration.
Prothonotary Warbler—*(Protonotaria citrea)*
At least two pairs probably nesting near the lakes in the Park.
Worm-eating Warbler—*(Helmitheros vermivorus)*
Rare summer resident.
Golden-winged Warbler—*(Vermivora chrysoptera)*
Scarce migrant. Occurs in the lowlands.
Tennessee Warbler—*(Vermivora peregrina)*
Frequent during migration.
Orange-crowned Warbler—*(Vermivora celata celata)*
Frequent migrant.
Nashville Warbler—*(Vermivora ruficapilla ruficapilla)*
Scarce migrant.
Northern Parula Warbler—*(Compsothlypis americana pusilla)*
Scarce during migration.
Eastern Yellow Warbler—*(Dendroica aestiva aestiva)*
Common summer resident of the marshlands.
Magnolia Warbler—*(Dendroica magnolia)*
Common migrant, usually of upland woods.
Cape May Warbler—*(Dendroica tigrina)*
Common migrant of the river bottoms but erratic in its appearance. Some years it does not show up at all.
Black-throated Blue Warbler—*(Dendroica caerulescens)*
Rare migrant.
Myrtle Warbler—*(Dendroica coronata)*
One of the most common migrant warblers, passing through with the first waves of migration in the spring.
Black-throated Green Warbler—*(Dendroica virens)*
Quite common during migration, seeming to prefer hawthorne trees.
Cerulean Warbler—*(Dendroica cerulea)*
Rare migrant.
Blackburnian Warbler—*(Dendroica fusca)*
Quite a common migrant but sometimes misses us on its migration paths.
Sycamore Warbler—*(Dendroica dominica albilora)*
A single specimen seen at close range in Ottawa by the junior author.
Chestnut-sided Warbler—*(Dendroica pennsylvanica)*
One of the more common migrants.
Bay-breasted Warbler—*(Dendroica castanea)*
More scarce than the former.
Black-poll Warbler—*(Dendroica striata)*
Frequent during migration.
Pine Warbler—*(Dendroica pinus)*
Scarce migrant of the uplands.
Western Palm Warbler—*(Dendroica palmarum palmarum)*
This and the following occur in the spring in large numbers. Not as conspicuous in the fall.
Yellow Palm Warbler—*(Dendroica palmarum hypochrysea)*
Occurs in the flocks with the former but more scarce.
Oven-bird—*(Seiurus aurocapillus)*
Common during migration and a frequent summer resident.
Northern Water-thrush—*(Seiurus noveboracensis noveboracensis)*
Scarce migrant. We have not been able to distinguish this from the Grinnel's so this record may be of one or both.
Louisiana Water-thrush—*(Seiurus motacilla)*
Common during migration and nesting in some of the canyons.
Kentucky Warbler—*(Oporonis formosus)*
Several pairs nest in the Park.
Connecticut Warbler—*(Oporornis agilis)*
A common migrant.
Mourning Warbler—*(Oporornis philadelphica)*
Scarce migrant.
Northern Yellow-throat—*(Geothlypis trichas brachidactyla)*
Common summer resident of the marshes.

Yellow-breasted Chat—*(Icteria virens virens)*
Frequent migrant.

Hooded Warbler—*(Wilsonia citrina)*
A scarce migrant.

Wilson's Warbler—*(Wilsonia pusilla pusilla)*
A scarce migrant of the uplands, preferring hawthorne groves.

Canada Warbler—*(Wilsonia canadensis)*
Frequent during migration.

American Redstart—*(Setophaga ruticilla)*
Common migrant and summer resident in the marshlands.

PLOCEIDAE—WEAVER FINCHES

English or House Sparrow—*(Passer domesticus domesticus)*
Common in the cities and around farms.

ICTERIDAE—BLACKBIRDS, ORIOLES, etc.

Bobolink—*(Dolichonyx oryzivorus)*
Frequent migrant and summer resident.

Eastern Meadowlark—*(Sturnella magna magna)*
Common in fields in summer.

Eastern Red-wing—*(Agelaius phoeniceus phoeniceus)*
Common summer and frequent winter resident.

Orchard Oriole—*(Icterus spurius)*
Scarce migrant, usually of river bottoms.

Baltimore Oriole—*(Icterus galbula)*
Frequent summer resident.

Rusty Blackbird—*(Euphagus carolinus)*
Huge flocks pass through during migration. A few winter here.

Brewer's Blackbird—*(Euphagus cyanocephalus)*
A single small flock seen. A specimen in the O. H. S. collection.

Bronzed Grackle—*(Quiscalis quiscula aeneus)*
Common in the summer.

Eastern Cowbird—*(Molothrus ater ater)*
Common in the summer.

THRAUPIDAE—TANAGERS

Scarlet Tanager—*(Piranga erythromelas)*
Frequent migrant and scarce summer resident.

FRINGILLIDAE—SPARROWS

Eastern Cardinal—*(Richmondena cardinalis cardinalis)*
Frequent to common permanent resident.

Rose-breasted Grosbeak—*(Hedymeles ludovicianus)*
Fairly common summer resident.

Indigo Bunting—*(Passerina cyanea)*
Common in summer. Many nest in Park.

Dickcissel—*(Spiza americana)*
Common along roads on the upland prairies.

Eastern Evening Grosbeak—*(Hesperiphona vespertina vespertina)*
One flock seen by the late W. E. Howard of O. H. S.

Eastern Purple Finch—*(Carpodacus purpureus purpureus)*
Quite common during migration.

Common Redpoll—*(Acanthis linaria linaria)*
A rare winter visitor.

Pine Siskin—*(Spinus pinus pinus)*
Scarce migrant.

Eastern Goldfinch—*(Spinus tristis tristis)*
Common all year but more so in summer.

Red-eyed Towhee—*(Pipilo erythrophthalmus erythrophthalmus)*
Quite common summer resident. Sometimes known as "Chewink" or "Ground Robin".

Eastern Grasshopper Sparrow—*(Ammodramus savannarum australis)*
A scarce migrant.

Leconte's Sparrow—*(Passerherbulus caudacutus)*
A quite rare migrant of the upland woods.

Western Henslow's Sparrow—*(Passerherbulus henslowi henslowi)*
Seen only once, during migration.

Eastern Vesper Sparrow—*(Pooecetes gramineus gramineus)*
A frequent summer resident of the prairies.

Eastern Lark Sparrow—*(Chondestes grammacus grammacus)*
A scarce summer resident. Seems to prefer the upland thickets.

Slate-colored Junco—*(Junco hyemalis hyemalis)*
Common winter resident.

Eastern Tree Sparrow—*(Spizella arborea arborea)*
Common winter resident.

Eastern Chipping Sparrow—*(Spizella passerina passerina)*
A frequent summer resident.

Eastern Field Sparrow—*(Spizella pusilla pusilla)*
Common summer resident of the uplands.

White-crowned Sparrow—*(Zonotrichia leucophrys leucophrys)*

Common migrant but not nearly as common as the following.

White-throated Sparrow—*(Zonotrichia albicollis)*
Common migrant.

Eastern Fox Sparrow—*(Passerella iliaca iliaca)*
A frequent winter resident, seeming to prefer the uplands, especially along hedge fences.

Swamp Sparrow—*(Melospizc georgiana)*
Quite common during migration in marshy places and a few nesting here.

Mississippi Song Sparrow—*(Melospiza melodia beata)*
Common permanent resident of marshy places.

Lapland Longspur—*(Calcarius lapponicus lapponicus)*
A very rare winter visitor.

Eastern Snow Bunting—*(Pletrophenax nivalis nivalis)*
A very rare winter visitor.

PROTOZOAN PARASITES OF THE BUFONINAE (AMPHIBIA)[1]

A. C. WALTON
Knox College, Galesburg

From a study of collected material and a survey of the literature, records are available as to the protozoan fauna of 54 species of toads belonging to the Bufoninae (53 species of *Bufo* and 1 of *Nectophryne*). A number of conclusions have been derived from this study.

1. Examples from all of the major areas of distribution of *Bufo* are represented—in some cases by abundant material (*Bufo* is not recorded from Australia).
2. The protozoan fauna of at least one of the more common species from each continent have been studied extensively.
   (a) Africa, *Bufo regularis*—32 spp. of protozoa
   (b) Asia, *Bufo melanostictus*—47 spp.
   (c) Europe, *Bufo bufo*—26 spp.
   (d) N. America, *Bufo americanus*—17 spp.
   (e) S. America, *Bufo marinus*—23 spp.
3. (a) 45 species of protozoa have been reported from African hosts.
   (b) 62 species have been reported from Asia and the adjacent islands of Borneo, Japan, Java, Philippines, Sumatra, etc.
   (c) 44 species have been reported from Europe.
   (d) 50 species have been reported from North America.
      (1) 40 species from Canada and the U. S. A.
      (2) 5 species from Mexico, Cuba, and Porto Rico.
      (3) 12 species from Central America.
      (A number of the same species occur in all three areas.)
   (e) 32 species have been reported from South America (mainly Brazil).
4. A total of 4 genera and over 200 species of protozoa have been reported.
5. The genera *Cepedea* (19 spp.), *Opalina* (35 spp.), *Protoopalina* (14 spp.), and *Zelleriella* (22 spp.) of the Opalinidae as well as *Balantidium* (11 spp.), *Nyctotherus* (7 spp.), and *Trypanosoma* (20 spp.) seem to be the most widely distributed and the most common protozoan forms.
6. *Trichomonas augusta* and *Trypanosoma rotatorium* seem to be the most nearly cosmopolitan species in their distribution.
7. The reported occurrence of *Nyctotherus cordiformis* from other than European hosts probably represents errors in specific identifications.
8. A number of new combinations are made in the nomenclature.
   (a) *Trichomastix* sp? of Dobell, 1910 is referred to the genus *Eutrichomastix* as recently defined by Kofoid.
   (b) *Trichomastix* sp? of Fantham, 1924 and *T.* sp? of Fantham, 1931 are similarly transferred to *Eutrichomastix*.

[1] Contribution from the Biological Laboratories of Knox College, No. 114.

(c) *Herpetomonas xenopi* Fantham, 1922, and *H.* sp? of Fantham, 1931 are transferred to the genus *Leishmania* to accord with the transfer of other amphibian herpetomonads recently announced.

(d) *Zschokkella prashadi* Ray, 1933 is declared a *nomen nudum* inasmuch as neither description nor figures have accompanied the original designation of the species.

9. A strong probability exists that *Opalina obtrigonoidea* Metcalf, 1923 is identical with *O. triangularis* Ghosh, 1918. In such case the various subspecies and varieties of *O. obtrigonoidea* should be referred to *O. triangularis* and should therefore become respectively, *O. triangularis americana* (Metcalf), *O. t americana rugosa* (Met.), *O. t. austricola* (Met.), *O. t. japonica* (Hara), *O. t. lata* (Met.), *O. t. maxima* (Met.), *O. t. orbiculata* (Met.), *O. t. plicata* (Met.), and *O. t. rugosa* (Met.).

10. The criteria used by Metcalf and others in the subdivision of certain of the species of the Opalinidae do not seem to be definite enough to enable other workers to recognize all of the varietal forms thus established (in many cases on the basis of study of poorly preserved material taken from preserved host specimens). The species designations seem to be valid, but doubt exists as to the validity of many of the subspecies and varieties reported. A host difference within the range of a limited area is of doubtful value in establishing subspecies when morphological differences in the parasite are impossible to catalog.

The following list includes the hosts and parasites used as a basis for drawing the above conclusions.

1. BUFO AMERICANUS (Canada, U. S. A.)
   1. Haemoproteus lanoraiea
   2. H. laurentiae
   3. H. lavalia
   4. Haptophrya michiganensis
   5. Karotomorpha swezyi
   6. Leptotheca ohlmacheri
   7. Nyctotherus (?)cordiformis
   8. Opalina obtrigonoidea americana
   9. O. obtrig. amer. rugosa
   10. Phacus sp? of Hegner
   11. Plasmodium bufonis
   12. Trichomonas augusta
   13. Trypanosoma gaumontis
   14. T. inopinatum
   15. T. lavalia
   16. T. montrealis
   17. T. rotatorium

2. BUFO AMERICANUS COPEI (Canada)
   1. Balantidium sp? of Metcalf
   2. Opalina discophrya

3. BUFO ANDERSONII (Africa)
   1. Haptophrya gigantea

4. BUFO ANGUSTICEPS (Africa)
   1. Protoopalina gariepensis

5. BUFO ARENARUM (S. America)
   1. Myxidium immersum
   2. Nyctotherus (?)cordiformis
   3. Trichomonas batrachorum
   4. Zelleriella antilliensis
   5. Z. antunesi
   6. Z. uruguayensis

6. BUFO ASPER (S. E. Asia)
   1. Cepedea siamensis

7. BUFO BOREAS (Canada, U. S. A.)
   1. Balantidium sp? of Metcalf
   2. Opalina obtrigonoidea maxima

8. BUFO BOREAS HALOPHILUS (U. S. A.)
   1. Opalina intermedia
   2. O. obtrigonoidea maxima
   3. Trichomonas augusta

9. BUFO BUFO (Europe)
   1. Balantidium entozoon
   2. Cepedea huergeri
   3. C. dimidiata
   4. Chilomastix caulleryi
   5. Chlamydophrys stercorea
   6. Copromonas subtilis
   7. Eimeria transcaucasia

8. Entamoeba currens
9. E. ranarum
10. Hexamita intestinalis
11. Isospora sp? of Wenyon
12. Karotomorpha bufonis
13. Leptomonas jaculum (experimental)
14. Monocercomonas rotunda
15. Nyctotherus cordiformis
16. Opalina cincta
17. O. ranarum
18. Plistophora bufonis
19. Retortamonas dobelli
20. Trichomonas augusta
21. T. batrachorum
22. T. granulosa
23. Trimitus parvus
24. Trypanosoma rotatorium
25. T. sp? of Grassi
26. T. sp? of Laveran and Mesnil

10. BUFO BUFO ASIATICUS (E. Asia)
    1. Opalina asiatica
    2. O. bufoxena
    3. Protoopalina axonucleata
    4. P. hexasoma

11. BUFO BUFO FORMOSUS (Japan)
    1. Cepedea fujiensis
    2. Opalina japonica

12. BUFO BUFO JAPONICUS (Japan)
    1. Protoopalina hexasoma

13. BUFO CALAMITA (Europe)
    1. Entamoeba ranarum
    2. Hexamita parva
    3. H. sp? of Kofoid, McNeil, and Bonestall
    4. Mastigamoeba hylae
    5. Protoopalina caudata
    6. P. intestinalis
    7. Syndyomita neglecta
    8. Trichomonas augusta
    9. T. batrachorum
    10. T. granulosa

14. BUFO CARENS (Africa)
    1. Eutrichomastix sp? (Fantham)
    2. Leishmania sp? (Fantham)
    3. Protoopalina octomixa
    4. P. viridis

15. BUFO CELEBENSIS (Celebes Is.)
    1. Cepedea celebensis

16. BUFO COGNATUS (U. S. A.)
    1. Opalina discophrya
    2. O. sp? of Trowbridge and Hefley
    3. Trichomonas augusta
    4. Zelleriella hirsuta

17. BUFO COMPACTILIS (U. S. A.)
    1. Balantidium sp? of Metcalf
    2. Nyctotherus sp? of Metcalf
    3. Opalina spiralis
    4. Trichomonas augusta
    5. Trypanosoma rotatorium

18. BUFO CONIFERUS (Cent. America)
    1. Balantidium sp? of Metcalf
    2. Zelleriella opisthocarya

19. BUFO CRUCIFER (S. America)
    1. Zelleriella antunesi
    2. Z. antunesi quadrata
    3. Z. uruguayensis

20. BUFO CRUENTATUS (Java)
    1. Balantidium sp? of Metcalf

21. BUFO DIVERGENS (Borneo)
    1. Cepedea celebensis

22. BUFO D'ORBIGNYI (S. America)
    1. Myxidium immersum
    2. Nyctotherus (?)cordiformis
    3. Trichomonas batrachorum
    4. Zelleriella antilliensis
    5. Z. antunesi
    6. Z. uruguayensis quadrata

23. BUFO FOWLERI (U. S. A.)
    1. Balantidium sp? of Metcalf
    2. Hexamita intestinalis
    3. Nyctotherus (?)cordiformis
    4. Opalina obtrigonoidea
    5. O. obtrig. americana
    6. O. obtrig. amer. rugosa
    7. O. obtrig. plicata
    8. O. obtrig. rugosa
    9. O. (?)triangularis
    10. O. triangulata
    11. O. virguloidea
    12. O. spp? of Brandt
    13. Trypanosoma rotatorium

24. BUFO GARGARIZANS (China)
    1. Cepedea buergeri sinensis

25. BUFO HAEMATITICUS (Cent. America)
    1. Balantidium sp? of Metcalf
    2. Cepedea dolichosoma
    3. Opalina sp? of Metcalf
    4. Zelleriella bufoxena

26. BUFO INTERMEDIUS (Mexico)
    1. Zelleriella intermedia

27. BUFO JERBOA (Borneo)
    1. Cepedea borneonensis

28. BUFO LEMUR (Porto Rico)
    1. Zelleriella microcarya

29. BUFO MACROTIS (India)
    1. Balantidium amygdali
    2. Cepedea sialkoti
    3. Nyctotherus reniformis

30. BUFO MARINUS (Cent. and S. America, and Zool. Gardens, England)
    1. Balantidium sp? of Kudo
    2. Dactylosoma ranarum
    3. Haemogregarina aguai
    4. H. bufo-marinus
    5. H. cayennensis
    6. H. darlingi (?) =
    7. H. sp? of Darling
    8. H. sp? of Franca
    9. H. sp? of Plimmer
    10. H. spp? of Wenyon (Eng.)
    11. Lankesterella sp? of Wenyon (Eng.)
    12. Myxidium immersum
    13. M. lindoyense
    14. Nyctotherus (?)cordiformis
    15. N. tejerai
    16. Opalina sp? of Pearse
    17. Saccamoeba renacuajo
    18. Trichomonas augusta
    19. T. vitali
    20. Zelleriella antilliensis
    21. Z. antunesi
    22. Z. artigasi
    23. Z. opisthocarya
    24. Z. paulista
    25. Z. sp? of Chen and Stabler

31. BUFO MAURITANICUS (Africa)
    1. Haemogregarina tunisiensis
    2. Protoopalina caudata
    3. P. intestinalis
    4. Trypanosoma bocagei
    5. T. rotatorium

32. BUFO MELANOSTICTUS (S. E. Asia)
    1. Balantidium bicavata
    2. B. sp? of Chakravorti
    3. Cepedea dimidiata
    4. C. formosae (China)
    5. C. metcalfi
    6. C. pulchra javensis
    7. C. punjabensis
    8. C. seychellensis angusta
    9. C. subcylindrica
    10. C. virgula
    11. Discophrya sp? of Metcalf
    12. Eimeria laminata
    13. Eutrichomastix(?) batrachorum
    14. E. sp? of Dobell
    15. Haemogregarina boueti
    16. H. nucleobisecans
    17. H. tonkinensis (China)
    18. H. sp? of Franca
    19. H. sp? of Houdemer
    20. H. sp? of Mathis and Leger
    21. H. sp? of Prowazek
    22. Hexamita sp? (of Dobell)
    23. Isospora wenyoni
    24. Nyctotherus (?)cordiformis
    25. N. papillatus
    26. Opalina chattoni
    27. O. coracoidea
    28. O. cora lahorensis
    29. O. minuta
    30. O. obtrigonoidea plicata
    31. O. plicata
    32. O. ranarum
    33. O. scalpriformis
    34. O. triangularis
    35. O. sp? of Bezzenberger
    36. Protoopalina formosae (China)
    37. Toddia sp? of Mathis and Leger
    38. Trichomonas batrachorum
    39. T. sp? of Dobell
    40. Trypanosoma bocagei magna
    41. T. bocagei parva
    42. T. chattoni
    43. T. rotatorium
    44. T. sp? of Laveran and Mesnil
    45. Zelleriella macronucleata
    46. Zschokkella auerbachi
    47. Z. prashadi *(nomen nudum)*

33. BUFO MONKSIAE (Mexico)
    1. Zelleriella opisthocarya

34. BUFO PARACNEMIS (S. America)
    1. Trypanosoma butantanense (experimental)
    2. T. rotatorium

35. BUFO PELTACEPHALUS (Cuba)
    1. Protoopalina sp? of Metcalf
    2. Zelleriella sp? of Metcalf

36. BUFO PHILIPPINICUS (Philippines)
    1. Cepedea philippensis

37. BUFO POLYCERUS(=B. latifrons) (W. Africa)
    1. Balantidium sp? of Metcalf
    2. Cepedea magna

38. BUFO PUNCTATUS (U. S. A.)
    1. Opalina obtrigonoidea
    2. O. (?)triangularis
    3. Zelleriella sp? of Metcalf

39. BUFO QUADRIPORCATUS (Sumatra)
    1. Cepedea philippensis

40. BUFO RADDEI (China)
    1. Opalina pekinensis
    2. O. raddei

41. BUFO REGULARIS (Africa)
    1. Entamoeba sp? of Fantham
    2. Eutrichomastix sp? (of Fantham)
    3. Giardia agilis (in tadpoles)
    4. Haemogregarina boueti
    5. H. froilano
    6. H. pestanae

7. H. tunisiensis (= H. sp? of Macfie)
8. H. sp? of Balfour
9. H. sp? of Bouet (?= H. boueti)
10. H. sp? of Franca
11. H sp? of Plimmer
12. Leishmania xenopi (Fantham, 1922)
13. Opalina sudafricana
14. Protoopalina nutti
15. P. regularis
16. P. stevensoni
17. P. transvaalensis
18. P. sp? of Metcalf
19. Toddia bufonis
20. Trichodina bufonis
21. Trichomonas batrachorum
22. Trypanosoma bocagei magna
23. T. bocagei parva
24. T. inopinatum
25. T. karyozeukton
26. T. magna
27. T. rotatorium
28. T. somalense
29. T. varani
30. T. sp? of Bouet
31. T. sp? of Laveran and Mesnil
32. T. sp? of Stevenson

42. BUFO REGULARIS GUTTERALIS (Africa)
    1. Opalina sudafricana gutteralis

43. BUFO RETICULATUS (Africa)
    1. Trypanosoma rotatorium
    2. T. somalense
    3. T. sp? of Laveran and Mesnil

44. BUFO SMITHII (Japan)
    1. Opalina ranarum smithi

45. BUFO SPINULOSUS (S. America)
    1. "Abibes" sp? of Escomel
    2. "Monadiens" sp? of Escomel
    3. Nyctotherus sp? of Escomel
    4. Opalina ranarum
    5. Trichomonas augusta
    6. T. batrachorum (in tadpoles)
    7. T. "hominis" of Escomel
    8. Zelleriella sp? of Metcalf

46. BUFO STERNOSIGNATUS (Mexico)
    1. Zelleriella ovonucleata bufonis

47. BUFO TERRESTRIS (U. S. A.) (= B. lentiginosus)
    1. Cepedea obovoidea
    2. Leptotheca ohlmacheri
    3. Myxidium serotinum
    4. Opalina triangulata

48. BUFO TYPHONIUS (Cent. America)
    1. Opalina panamensis
    2. Zelleriella opisthocarya

49. BUFO VALLICEPS (U. S. A.)
    1. Balantidium sp? of Metcalf
    2. Leptotheca ohlmacheri
    3. Nyctotherus (?)cordiformis
    4. Opalina obtrigonoidea
    5. O. (?)triangularis
    6. Retortamonas dobelli
    7. Trichomonas augusta
    8. Zelleriella intermedia
    9. Z. intermedia cuneata

50. BUFO VARIEGATUS (S. America)
    1. Balantidium sp? of Metcalf

51. BUFO VIRIDIS (Europe)
    1. Cepedea dimidiata
    2. Opalina ranarum
    3. O. ranarum lata
    4. Protoopalina caudata
    5. Trichomonas batrachorum
    6. Trypanosoma rotatorium
    7. T. sp? of Laveran and Mesnil

52. BUFO WOODHOUSEI (U. S. A.)
    1. Balantidium sp? of Metcalf
    2. Opalina woodhousii
    3. O. sp? of Trowbridge and Hefley
    4. Zelleriella woodhousii
    5. Z. sp? of Chen and Stabler
    6. Z. sp? of Metcalf

53. BUFO spp? (Europe)
    1. Haemogregarina sp? of Hoare
    2. Isospora lieberkühni
    3. I. sp? of Grassi
    4. Lankesterella minima
    5. Nyctotherus amaniensis
    6. Trichodina urinicola
    7. Trichomonas mirabilis
    8. Trypanosoma sp? of Stevenson

54. NECTOPHRYNE HOSEI (Borneo)
    1. Cepedea hosei

COLLEGIATE SECTION

GALL INSECTS TAKEN AT PRINCIPIA COLLEGE, ELSAH, ILLINOIS

JEANNE R. EHRENBORG

A study of gall insects has been made over a period of four years at Principia College, Elsah, Illinois, by C. L. Remington and the writer. This study has included the rearing of gall insects in the laboratory and observations in the field. Acknowledgment for identifications should be made to Dr. L. H. Weld for Cynipoidea; to the late Dr. E. P. Felt for Cecidomyiidae; to Dr. J. McDunnough for moths; to Mr. R. A. Cushman for Ichneumonidae, and to Mr. A. B. Gahan for Chalcidoidea.

Identifications of gall insects and parasites are very difficult to make; therefore a large number of specimens has not yet been determined.

A very large proportion of the insects which have emerged from galls in the laboratory have been parasites, and in many cases the actual gall-maker remains unknown. Students of gall insects in the United States have found that the Cynipidae or gall wasps and Cecidomyidae or gall flies include by far the greater number of gall-makers, while various aphids, and mites of the family Eriophyidae also cause many galls. A relatively small number of galls are caused by the dipterous families Trypetidae and Agromyzidae, certain sawflies and chalcid-wasps, a few species of moths, and very few Coleoptera. This has proved precisely the case in the vicinity of Elsah. It seems desirable to give an annotated list of gall insects and their parasites which have thus far been identified.

HOMOPTERA

Family Aphididae.

Phylloxera caryae-fallax Riley. Several specimens emerged from hemispherical gall on *Carya* leaflet, spring 1943.

LEPIDOPTERA

Family Lavernidae

Walshia amorphella Clemens. Reared from twig galls on False Indigo *Amorpha fruticosa:* Apr. 21 and 29, 1943. Parasitized by ichneumons: *Acrolyta empretiae* Ashm., *Pristomerus ocellatus* Cush., and *Calliephialtes graphollithae* Cress.

Family Gelechiidae

Gnorimoschema gallaesolidaginis Riley. Very common. Parasitized by *Sesioplex depressus* Viereck. The elliptical stem gall on *Solidago.*

DIPTERA

Family Cecidomyiidae

Lasioptera n. sp. Reared from elliptical stem gall on *Chenopodium alba.*

Neolasioptera ramuscula Beuten. Host: stem gall on *Aster multiflorus.* Very abundant, parasitized by *Platygaster* sp. (probably *P. puto Ashm.*) and by *Tetrastichus* sp. and *Eupelmus* n. sp.

Family Trypetidae

Eurosta solidaginis Fitch. One of the commonest gall makers in the Elsah area. Causes the large globose stem gall on *Solidago.* Overwinters as pupa. Adults emerge in April and May.

HYMENOPTERA

Family Cynipidae

Kleidotoma sp. One female take Apr. 26, 1943.

Aulacidea podagrae Bassett. Ten reared from large knobby stem gall on *Lactuca.* May 31, 1943.

Diastrophus nebulosus Osten Sacken.

Numbers emerged from gall on *Rubus*: March 11 and 13, 1942; Apr. 15, 1943. Parasites reared include: *Callimome sackeni* Ashm., *Ormyrus ventricosus* Ashm., and an unidentified pteromalid.

Callirhytis futilis Osten Sacken. Two agamic females taken Apr. 12, 1943.

Zopheroteras hubbardi Ashm. Female found in rotten log March 30, 1943, by Daniel Starrett. Dr. Weld knew of only four other specimens, taken in Michigan, New York, Maryland and Virginia.

Dryocosmus palustris Osten Sacken. Female emerged from twig gall of *Quercus* sp. May 16, 1943.

Dryocosmus deciduus Beutenmueller. Female taken April 17, 1943.

Synergus walshii Gill. One male of this guest wasp emerged from round compound gall 5 mm. in diameter on underside of leaf of *Quercus alba* found on ground in winter. Ex-pupa Apr. 11, 1943.

Loxaulus "sp. No. 14". Mr. Weld returned it so labeled. Female taken April 17, 1943.

Euceroptres primus Ashmead. One swept from grass April 29, 1943.

MEMORIALS

R. MAGOON BARNES
1862-1945

R. Magoon Barnes was born at Lacon, Illinois, April 21, 1862. He died at Hennepin, Illinois, July 19, 1945, in his 83rd year.

R. Magoon Barnes was a student at Northwestern University, 1879-1880, and from 1880-1883 at Illinois Wesleyan Law School where he received his bachelor's degree in Law. He was admitted to the Illinois bar the same year and practiced law until his death.

Judge Barnes was one of those many-sided individuals who was not only outstanding in his chosen profession but who found the opportunity in his busy life to devote much time and valuable effort to civic affairs in his community, to the study of natural history, especially ornithology, geology, palaeontology and conservation. He was particularly interested in birds and bird life. For many years he published the *Oologist* but finally discontinued it in 1941.

Some years ago Judge Barnes established a private natural history museum in a specially constructed building near his home. All interested persons, school children especially, were welcome at all times to visit it. For his services to the community for furthering scientific knowledge and making important collections, Judge Barnes was appointed assistant curator of Oology in 1898 at the Chicago Museum of Natural History (then the Field Museum).

In 1925 he placed in the "Field Museum of Natural History his largest and by far the most complete serial study collection of North American birds' eggs in existence, 38,721 specimens," and has since increased it by "a considerable number of additional and rare varieties."

The lawyer and naturalist was mindful of his duties as a citizen, too. He was elected to various offices in the local government—city attorney 1885-1887, treasurer 1887-1889, Mayor of Lacon 1889-1891, and Mastery in Chancery, Marshall County Circuit Court 1891-1901. He was for many years a member of the Lacon School Board, a director of the First National Bank of Lacon, and president of the Citizens National Bank of Toluca.

In 1937 he was appointed to the Board of State Museum Advisors with which he had met at Governor Horner's request for some years previously. He entered with characteristic thoroughness and enthusiasm into his new duties, among other undertakings securing for the Illinois State Museum the very excellent A. E. Price egg collection which he further supplemented from his own museum specimens. Judge Barnes was a strong advocate for a new state museum building which would permit adequate extension services to schools and rural communities as well as ample storage and exhibit space in the museum itself.

R. Magoon Barnes, with his keen sense of humor, his mental alertness, and his fine physical appearance seemed a much younger man than his years. He spent his last day in court and spoke for over an hour in defense of a client. His death leaves a void in scientific and museum fields that will be difficult to fill.

—THORNE DEUEL,
Illinois State Museum

DELIA CALDWELL
1860-1945

Dr. Delia Caldwell was born in Hopkinsville, Kentucky March 25, 1860, the seventh child of Isaac Hudgen Caldwell and Evaline Stites Caldwell. Her death occurred at her home in Carbondale, Illinois November 28, 1945.

The Caldwell family was of English ancestry. The mother of the famous Southern statesman, John Caldwell Calhoun, was a member of this Caldwell family. Dr. Caldwell's mother was a grandniece of Richard Johnson, Vice President of the administration of Martin Van Buren.

The Caldwell family moved from Hopkinsville, Kentucky, to Carbondale, Illinois, in 1868. Delia Caldwell was then about eight years of age. In 1878 she graduated from the Southern Illinois Normal University in the third graduating class of the school. After teaching in the public schools for several years, she entered the Medical College of Northwestern University, graduating from that institution in 1895. Dr. Caldwell began the practice of medicine at Paducah, Kentucky, where she continued to practice for 23 years.

In 1918 she moved to Carbondale, Illinois. About three years after she came to Carbondale, she was called upon by the late President H. W. Shryock to become a member of the faculty of the Southern Illinois Normal University, to establish the health department in the school. She did much for the basic organization and development of the health work on the campus, making possible the present efficient Department of Health in the institution. In 1935 she retired from active service in the school with the status of Professor Emeritus.

Dr. Caldwell was a member of the American Medical Association, the American Medical Women's Association, the Illinois State Academy of Science, the National Society of the Daughters of the American Revolution, and numerous other organizations. In her busy life she always found time to serve in religious, social, and civic institutions for the welfare of the community and mankind in general.

—Wm. M. Bailey,
Southern Illinois
Normal University

ALBERT PRUDEN CARMAN
1861-1946

Albert Pruden Carman was born in 1861 in New Jersey, the son of a minister. He attended Princeton University and graduated from that institution in 1883 with the A. B. degree. The fact that he had already distinguished himself as a scholar is indicated by his appointment at that time as a teacher and fellow at Princeton. He also obtained the degree of Master of Arts there in 1884, and a Doctor of Science in 1886. While doing his graduate studies at Princeton, Professor Carman served as an instructor in physics and mathematics.

Still ambitious to learn and to prepare himself for the outstanding career which was to follow, Professor Carman attended the University of Berlin in 1888-1890 where he had the privilege of being a student of Helmholz.

Returning to America in 1890, he accepted the position of Professor of Physics and Electrical Engineering at Purdue University, serving in this capacity until 1893 when he joined the faculty of Stanford University as Professor of Theoretical Physics. He maintained the connection with Stanford until 1896, though the last year of this period was spent in further study at the University of Vienna.

It was in September of 1896 that Professor Carman came to the University of Illinois as head of the physics department and in charge of electrical engineering. At this time the profession of electrical engineering was rapidly developing and these duties were taken over by a full-time man in 1897, Professor Carman concentrating all his energies on physics. He remained as head of the department of physics until 1929, when he retired from active duty after serving the University of Illinois for thirty-three years.

Professor Carman was very proud of the department of physics which grew up under his direction during his years of service to be one of the outstanding departments in the nation. In all these years Professor Carman exhibited a primary interest in training his students in the knowledge and appreciation of the laws of nature and in the growth and professional development of his colleagues.

During these years at Illinois he wrote the section on electricity and magnetism of the classical textbook of physics edited by Duff. He saw to the planning and equipping of the present physics laboratory which, completed in 1910, remained one of the best laboratories of physics for many years. He organized the first professional curriculum in engineering physics in the United States, anticipating by many years the importance of thorough training in physics now so clearly recognized by the foremost engineering schools.

While always maintaining a first interest in teaching, Professor Carman found time for significant research. He directed important and fundamental research in the field of dielectrics, and cooperated with his staff in engineering research. He was aware that the good teacher must take an active interest in research, and encouraged his staff to maintain a like interest.

He was a great reader and spent many hours in the library of the department, keeping in touch with the rapid development in physics which occurred during his life. There were few items which escaped his attention, and the breadth and clarity of his understanding was

often a surprise to those who sought his advice in technical fields.

All through his life he maintained a keen interest in his associates, and he counted as these all those who contributed to the development of knowledge, though he remained always loyal to his own field. This broad personal interest gave Professor Carman many friends, and he was respected and admired by all who knew him.

Coming to the University of Illinois of Illinois in 1896, he knew the region when it was still a rural community. He took an active interest in the growth and development of the twin cities. He was married in 1900 to Maude Wheeler Straight, then on the university staff, and both Professor and Mrs. Carman took a keen interest in student activities.

Professor Carman experienced great loss in his later years due to failing vision. He met this difficulty, however, with cheerful fortitude and maintained his scholarly interests up to his death which occurred on the 10th of February, 1946.

His life will be remembered long as one of continued devotion to the cause of education. His loyalty to his work and to the University he served, is exemplary; his sincerity and personal integrity, outstanding. His scholarship was broad and sound, and he gave of his knowledge freely and unselfishly to the development of the University which he served. If we look in the University Register for 1944-45 we find the name of Albert Pruden Carman following that of David Kinley. Both of these names will be gone from the Register of 1945-46. These men were contemporaries, and alike in their loyal service to the University of Illinois.

—F. W. Loomis
—E. H. Williams
—R. F. Paton
University of Illinois

THEODORE HENRY FRISON

(1895-1945)

THEODORE HENRY FRISON

1895-1945

Theodore Henry Frison was born in Champaign, Illinois, January 17, 1895, and died in Champaign, December 9, 1945. Dr. Frison spent most of his life in Champaign-Urbana, where he attended Champaign High School and later the University of Illinois. During his high school years, he was a neighbor of J. W. Folsom, who tutored him in his early interest in entomology. Dr. Frison's college career was interrupted in 1918 when he entered the army, was commissioned a second lieutenant and resigned in December of the same year to resume his study of entomology at the University of Illinois. There he received his B.A. in 1918, M.A. in 1920, and Ph.D. in 1923.

In 1920, after receiving his master's degree, he was appointed Assistant State Entomologist of Wisconsin. In 1921-22, he joined the staff of the Illinois Natural History Survey as Systematic Entomologist. In 1917, the State Laboratory of Natural History and the office of State Entomologist had been merged to form the Natural History Survey, with Forbes as Chief. Upon Forbes' death in 1930, Frison became acting head of the Survey, and on July 1, 1931, he was named Chief, a position he has since held.

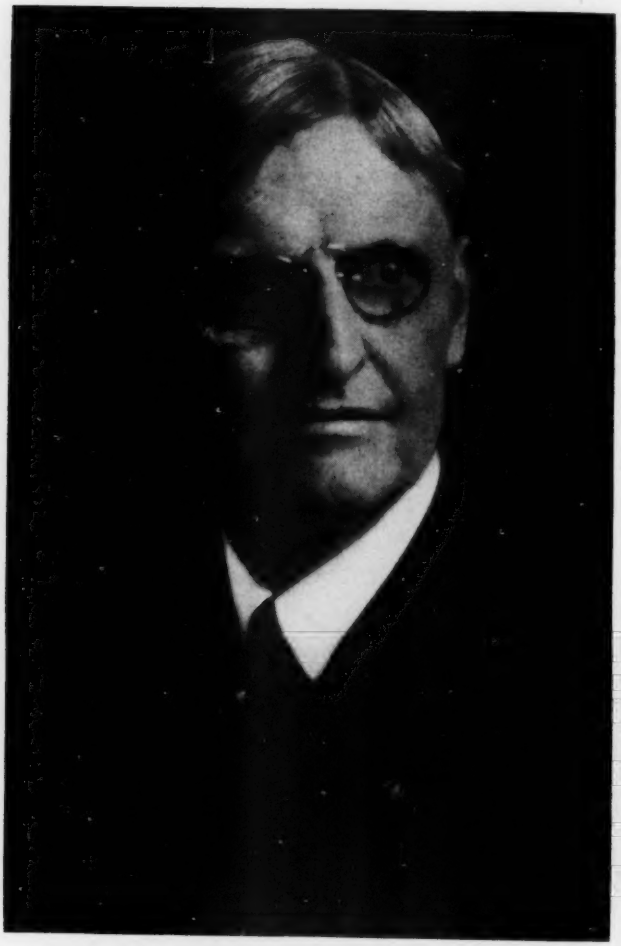
Dr. Frison was internationally known for his studies of bumblebees, aphids, and stoneflies, and he continued his work on these groups, especially the stoneflies, until his last illness.

After he became Chief of the Natural History Survey, administrative duties claimed much of his time. Under his direction, the modern laboratories and offices of the Survey in the Natural Resources Building were planned and completed. He took an active interest in wildlife research in Illinois and was one of the principal persons responsible for the organization of the Midwest Wildlife Conference, whose first meeting was held in Urbana in 1935. He also took a very active part in the Illinois State Academy of Science and served as President of that organization in 1931-32. He has been a Director of the Central States Forestry Congress since 1933 and of the Illinois Audubon Society since 1942. He was Editor of the Journal of Economic Entomology from 1936 to 1939, and a Vice President of the Entomological Society of America in 1935.

Among entomologists he will always be remembered for his rejuvenation of the Insect Survey of Illinois. Definite plans for this were laid in 1927 and resulted in the beginning of a series of comprehensive reports on the biology, distribution, and taxonomy of various groups of Illinois insects. In this series, Dr. Frison published "The Fall and Winter Stoneflies of Illinois" (1929), "The Plant Lice of Illinois" (Hottes and Frison 1931), "The Stoneflies of Illinois" (1935), and "Studies of North American Plecoptera, with Special Reference to Illinois" (1942). Dr. Frison envisaged the insect collection not only as a museum but as a storehouse of information to support biological and economic investigations over a broad field.

The entomological and biological fraternity has suffered a great loss in his passing.

—Herbert H. Ross
Illinois State Natural History Survey



HENRY BALDWIN WARD
(1865-1945)

HENRY BALDWIN WARD

1865-1945

Henry Baldwin Ward received his Ph.D. degree from Harvard in 1892. Two years previous to this he studied in the European Universities of Göttingen, Freiburg, and Leipzig, and at the biological stations of Naples, Heligoland, and Ville-Franche-sur-Mer. He became interested in parasitology under the famous Rudolph Leuckart. His father, R. H. Ward, a physician, was one of the founders and first President of the American Microscopical Society. Thus in training and heredity there was a precedent for his outstanding contributions to the development of the biological sciences in the United States.

Following a year's instructorship at the University of Michigan he went to the University of Nebraska where promotions brought him to the Headship of the Department of Zoology and then to Dean of the Medical School. As Head of the Department of Zoology at the University of Illinois from 1909 to 1933 his department became a mecca for parasitologists the world over. He was founder and managing editor of the *Journal of Parasitology* from 1918 to 1932 and the first President of the American Society of Parasitology. His leadership in the field of parasitology was recognized abroad by memberships in scientific societies of Germany, France, Russia, Italy, Czecho-Slovakia, Bohemia, and Venezuela. Visiting professors from foreign lands were shared with graduate students in private conferences and evening smokers in his home. Among these were Professors Nuttall from England, Brumpt from France, Fülleborn from Germany, Katsurada from Japan, and many others.

He was always concerned about his graduate students and justly followed their successes with pride, but for the indolent he had no favors. Few knew about his financial aids to struggling graduate students. He kept scrupulous notes on all phases of his activities and filed all items of general as well as scientific value, so that over the years they were voluminous in extent. His library in parasitology was second to none and was open for the use of graduate students and staff alike.

Traditionally he was known as a strict disciplinarian to successive generations of freshmen in general zoology. The hats of both sexes were removed in his class room and watches were left in their pockets. A hush settled over the lecture room as he stepped out from the door of the chart room behind the lecture desk. His blue eyes swept at a glance the parade of charts on the wall, then leveled on any student still engaged in conversation beyond the stroke of the bell. He held the floor. However, the fatherly advice and counsel beyond the concepts of zoology which he gave to his classes prevented thousands of students from making fundamental errors in the preparation for careers. Schooled in the methods of Professors Louis Agassiz and E. L. Mark, few teachers have had so great an influence upon the lives and careers of students as Henry Baldwin Ward.

He possessed almost boundless energy and vigor which he constantly renewed by his ability to drop off at frequent intervals into little naps. On the public platform or in the class room those of us who knew of this habit were aware that the keenness of his mind during such inter-

vals responded and reached new high levels. Once as a class we attempted to withdraw quietly before he looked up, but at the critical moment he sprang to his feet, walked down the aisle, and congratulated the speaker and discussed with him the salient points of the lecture, leaving in our minds doubts as to whether or not he really had slept.

Long after his seventieth birthday he was taking Saturday afternoon hikes with the University Hikers' Club. Baseball and home runs were taken in their stride. It was on such occasions that one came to know his stories, his sage discussions, and the deep bass voice that boomed out in songs around the camp fire. That same voice responded for years to the Choral Society Director's baton.

He was a great organizer of the machinery of science. The American Association for the Advancement of Science, Sigma Xi, the State Academies of Science, all have felt his influence in their development. As a charter member and past president of the Illinois State Academy of Science and as a member of important committees he worked diligently over the years with the State Museum Board, of which he was also a member, to put the *Transactions of the Illinois State Academy of Science* on a firm foundation.

Early in 1894 as a member of the U. S. Fish Commission, he became associated with Professor Jacob Reighard of the University of Michigan on a biological survey of the Great Lakes. While industries were erecting power dams, blocking salmon runs, polluting streams, and canning the fish as though there were no limit, Professor Ward was investigating and predicting their ultimate destruction under prevailing practices. Relief measures came almost too late for many salmon runs of our Pacific Coast.

As Past-President of the Isaac Walton League of America he continued his efforts to interest the public in sound conservation education and was working on manuscripts in this field the evening before his death. He died quietly in his sleep on the morning of November 30, 1945.

Thus passed on a great zoologist, a staunch friend of the Illinois State Academy of Science and the founder of the science of Parasitology in America.

—Lyell J. Thomas
University of Illinois

ADA LOUISE WECKEL

Ada Louise Weckel, for many years a member of the Illinois Academy of Science, died last July after a week's illness.

Miss Weckel was graduated from the University of Michigan in 1905, taught two years in Portage, Wisconsin, after which she took her master's degree at the Universsity of Chicago in 1908. She was elected at that time to Sigma Xi. Her work on Amphipods, with a key to the species, was for many years the authority on that group, and in recognition of this, her picture is in the Smithsonian Institute.

After one year of teaching at St. Louis, and a summer of further study in Germany she came to Oak Park High School in 1909. Here, she and Mr. J. L. Thalman organized one of the first courses in general science, and together they wrote one of the early text books on that subject.

When Mr. Thalman left in 1914 she took his place as head of the Science Department which at that time included general science, botany, and zoology. In 1923 she was made dean of freshmen girls. Responsibility and administrative work increased as the school doubled in size, and doubled again, but Miss Weckel found time to make the well known series of models for her zoology class. They are used in many schools today.

Miss Weckel was gifted with great energy and driving force. She used to say that she hated to have any unfinished work on her desk at night. At the same time she was a person of unusual charm and tact, with an enormous capacity for friendship.

It was her very genuine interest in people that made her the supremely capable advisor that she was, not only to the freshman girls and their mothers but also to her own pupils and teachers who were fortunate enough to work with her. Her clear and lovely mind, her keen insight and rare judgment, and her unfailing sympathy caused great demands on her time. Many, many people have laid their problems and troubles on her desk and, with her aid, have balanced the pros and cons, and have gone away relieved in mind, and firm in the conviction that they had made the right decision.

In June 1944 she retired, and in the year that followed took an active part in the life of the Village, where she was always in great demand, especially for club programs. But she enjoyed her freedom for only one year. On the 12th day of July 1945, we received the word that she was gone. Her influence and her friendliness will long be remembered.

—Ruth Williston

ACADEMY BUSINESS

SECRETARY'S REPORT ON THE BUSINESS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

For the Year May 7, 1945 to May 5, 1946

Compiled by LEO R. TEHON, *Secretary*
Illinois State Natural History Survey, Urbana

The year covered by this report has seen the nation both at war and engrossed in restoring the pursuits of peace.

The Annual Meeting of the Illinois State Academy of Science reflected both phases. The small number of papers presented—a result, no doubt, of the preoccupation of the membership during several years with problems of defense—emphasized the continuing effects of war. But revival of interest and evidence of renewed vigor were also apparent. Although no accurate registration could be kept, attendance at the Annual Meeting was estimated as more than 600 persons, perhaps the largest attendance in the history of the Academy. Over 200 of the persons present were members of the State Academy of Science; 350 were members of the Junior Academy of Science; and perhaps 50 others attended the Collegiate Section program.

The Academy may look confidently to the future. Its membership, although smaller than before the war, is still among the largest of the State Academies. Its Collegiate Section, an almost unique organization, attracted the participation and interest of college students to such a degree as to become a model for similar groups. The Junior Academy of Science, enthusiastic always, has regained all lost ground and has added to its achievements the publication of a Yearbook. The numbers, both of life members, whose contributions constitute a permanent endowment, and of sustaining members, whose contributions are used exclusively to support the Junior Academy activities, have increased notably. Notable, also, is the increase in the "national" membership of the Academy, upon which is based the amount received from the American Association for the Advancement of Science for the awarding of research grants. Collection of dues has been good and, under the specific recommendations of the Committee on the Budget, the Academy has conducted its affairs economically and grown steadily in resources. Life membership fees lately received have been invested in U. S. government bonds. Because of careful supervision of expenditures, the Academy's resources on April 30, 1946, were in excess of $1800.

1. COUNCIL MEETINGS

Four meetings of the Academy Council were held during the year, with President A. E. Emerson presiding at all but the first.

The first Council meeting, with Vice-President McGregor presiding, was held at Normal, Illinois, immediately after the Executive Session which replaced the regular Annual Meeting on May 5, 1945, and included most of those in attendance at the Executive Session. The newly elected officers were introduced and it was voted that, if war conditions permitted the holding of an Annual Meeting in 1946, that meeting should be held at Illinois State Normal University and that Dr. Ralph U. Gooding should continue as Second Vice-President and Chairman of the Committee on Local Arrangements. Dates for the Annual Meeting were not set.

The second Council meeting was held during the afternoon of November 24, 1945, at Normal, Illinois, with the following persons present: A. E. Emerson, J. C. McGregor, R. U. Gooding, L. R. Tehon, John Voss, H. R. Wanless, Mrs. Mary Creager, O. B. Young, L. J. Thomas, G. H. Dungan, H. F. Thut, T. T. Quirke, C. E. Ireland, W. W. Crawford, Percival Robertson, Mrs. Grace M. Jaffé, E. L. Stover, and Thorne Deuel. Minutes of the previous meeting were approved. The Treasurer reported on hand a balance of $1,341.65. The Committee on Codification of Council Actions, Miss Marguerite Simmons, Chairman, reported the completion of its work and was discharged with the thanks of the Council. The Editor's report that manuscripts for the Transactions had been edited and sent to the printer earlier than usual was received. For the Committee on Memorial Forests, Professor Thomas reported progress and favorable acceptance in many quarters. Activities of the Special Committee on a New State Museum Building were reported by Professor Robertson. The request of this Committee that it be discharged was denied, and the committee was directed to remain in touch with the Director of the State Museum, keep the Council informed, and propose future action by the Academy. On the Project for Development of Research, Professor Young reported on conferences with the State Superintendent of Public Instruction regarding a plan for developing and supervising state awards for research, the funds to be allocated through the office of the State Superintendent of Education. On motion by Professor Robertson and second by Mr. McGregor, Professor Young was made chairman of an Academy committee to develop details and make a formal proposal and was requested to suggest to the President other suitable members. (Subsequently, as appointed by the president, the committee consisted of O. B. Young, Chairman, J. C. McGregor, H. R. Wanless, T. T. Quirke, Percival Robertson and Bruce Merwin.)

On advice regarding the program at Illinois State Normal University by Dr. Gooding, the dates May 10 and 11, 1946, were set for the Annual Meeting. The Secretary was directed to arrange, if possible, with the State Geological and Natural History surveys for resumption of the field trips provided by these organizations in pre-war years, and two additional field trips to local points of interest were suggested. Mrs. Creager reported on plans for the Junior Academy, the work being done by the Junior Academy, and plans for participation at the Annual Meeting; her report was approved and accepted. President Emerson discussed at length the scientific problems being posed by the atom bomb and requested approval to send to the membership of the Academy a statement prepared by men at the University of Chicago who had been engaged in atomic research. On a motion by Professor Robertson, seconded by Professor Jaffé, this permission was granted. The date for the next Council meeting was set for February 9, 1946, and adjournment followed.

The third Council meeting was held on the afternoon of February 9, 1946, at Normal, Illinois. Present were A. E. Emerson, L. R. Tehon, W.W. Crawford, G. H. Dungan, R. U. Gooding, O. B. Young, J. C. McGregor, Mrs. Mary Creager and Miss Dorothy Rose. Reading of the minutes of the previous meeting was omitted. No report was received from the Treasurer who was absent because of illness. The Editor reported that all galley proof for the Transactions had been returned by authors and had been sent on for final printing. Professor Thomas, reporting on the Memorial Forests project, stated that the American Legion had approved of the project, as had also the American Federation of Labor. Professor Young reported regarding the Research Development project that Professor Wanless and Professor Quirke, members of this committee, had prepared a questionnaire which would be sent to the membership of the Academy to learn the general attitude of scientists in the state toward additional research funds. Professor Gooding reported that since the Council meeting of November 24, when the dates May 10 and 11 had been selected for the Annual Meeting, circumstances had

arisen in Bloomington and Normal which made it inadvisable to hold the meeting on those dates. At his suggestion, the dates for the meeting were changed to May 3 and 4, the fourth Council meeting to be held as a dinner and evening meeting on May 2. Local arrangements for the Annual Meeting outlined by Professor Gooding were approved by the Counci., including the holding of the Annual Banquet in one of the churches in Normal at a cost of not more than $1.25 per plate. Mrs. Creager reported on plans for the meeting of the Junior Academy in conjunction with the Annual Meeting. She was authorized to prepare the customary senior Academy award certificates for projects of outstanding merit. Mr. McGregor, on behalf of the Librarian and the Illinois State Museum, raised the question of disposal of publications received by the Museum in exchange for the Transactions of the Academy, pointing out that the Transactions were printed at the expense of the State of Illinois and were mailed through the Museum, that exchange publications received at the Museum were now being maintained as a separate Academy library, and that it seemed desirable in planning the new State Museum building, in which permanent quarters for the Academy were being allotted, to have a more definite agreement than has existed in the past regarding exchanges. Upon request of the Secretary, this question was deferred until the next Council Meeting.

President Emerson appointed the following special committees and instructed them to be prepared to report at the General Business Meeting of the Academy: *Committee on Nominations*, O. B. Young, Chairman, L. J. Thomas, and C. L. Furrow; *Committee on Auditing*, W. W. Grimm, Chairman, Walter W. Thomas, and L. P. Elliott; *Committee on Necrology*, Gilbert Wright, Chairman, G. D. Fuller; *Committee on Resolutions*, T. T. Quirke, Chairman, Clarence Bonnell, and J. C. McGregor.

The Fourth Council meeting was held at the Hotel Rogers in Bloomington on May 2, 1946, with 18 Council members and Section Chairmen present. A complete and satisfactory report on local arrangements was received from Professor Gooding. Reports regarding plans for the geology and natural history field trips sponsored by the State Geological and Natural History surveys and local industrial trips were also received. Plans for the Junior Academy meeting were outlined by Mrs. Creager. She was authorized, on motion by L. J. Thomas, to proceed with publication of the Junior Academy Yearbook, the Academy of Science to contribute within the limits of its budget. Discussion of funds for the support of the Junior Academy brought out the need for a Committee on Sustaining Memberships to function separately from the Committee on Affiliations. A motion by O. B. Young that such a committee be established and a chairman and members be appointed by the President was carried. Discussion, deferred from the last Council meeting, was resumed regarding the disposition of publications received by the Illinois State Museum in exchange for Transactions of the Academy. After the Secretary presented a resume of previous actions of the Council recorded in the Transactions, L. J. Thomas moved that: *The Council of the Academy approves the statement that all publications received by the Illinois State Museum in exchange for Transactions of the Illinois State Academy of Science be and remain the property of the Illinois State Museum.* This motion was passed unanimously. A statement of the policy of the Academy regarding use of the stock of Transactions for supplying post-war requests was desired by the Librarian. It was moved by L. J. Thomas that the Librarian be authorized to use the stock of back numbers of the Transactions, when in his judgment a sufficiently large surplus was on hand, to supply requests for the rebuilding of war-destroyed libraries. This motion was passed unanimously. Discussion of the cost of reprints of articles printed in the Transactions brought from the Librarian the statement that the Academy might adopt a practice of allowing or requiring authors to order reprints prior to the forwarding of the requisition for printing to the State

Division of Printing, so that reprints could be included as a part of the original printing order, thus giving authors the advantage of the state printing rate, the authors to be billed for reprints through the Treasurer of the Academy. A motion, stated by the Secretary at direction of the President and seconded by L. J. Thomas, that the Council approves in principle the reprint handling suggested by the Librarian was unanimously passed.

2. GENERAL BUSINESS MEETING

The preliminary Business Meeting of the Academy was called to order by President Emerson at 9:45 A.M. on May 3, 1946, at Illinois State Normal University. Reading of the minutes of the previous General Business Meeting, already printed and distributed in the Transactions, was omitted. President Emerson publicly announced the chairmen and memberships of the special committees on nominations, auditing, resolutions, and necrology and requested the membership of the Academy to confer with these committees prior to the General Business Meeting scheduled for the afternoon. Necessary announcements were made. There being no new business from the floor, the meeting was adjourned.

The General Business Meeting was called to order by President Emerson at 5:00 P.M. on May 3, 1946, at Illinois State Normal University. A slate of new officers and standing committees was presented by the Committee on Nominations, O. B. Young, Chairman. There being no additional nominations from the floor, the Secretary was directed to cast a unanimous ballot for the slate presented. The report of the Treasurer was received and accepted. The report of the Committee on Auditing, which found the treasurer's records in order and correct, was accepted. The Committee on Resolutions, T. T. Quirke, Chairman, reported nine resolutions for consideration by the membership of the Academy. (These resolutions are printed in full below.) Resolution No. 1, regarding a world government, received much discussion. Professor Percival Robertson moved an amendment to read *through the United Nations or any other suitable organization*, which was defeated by vote. Professor Quirke moved an amendment to read *authority for government*, which amendment was also lost by vote. The original motion for adoption of the resolution was then passed, with dissenting votes. Resolution No. 2 was passed as originally offered, by unanimous vote after having had an amendment proposed to insert *by adequate appropriations*. Resolution No. 3, pertaining to Senate Report No. 1850, generally known as the Kilgore-Magnuson Bill, was amended by a vote, which was not unanimous, to include the phrase *the principles expressed in the present bill*, and the motion to adopt the resolution as amended was carried by a vote which also was not unanimous. Resolution No. 4 was passed by a unanimous vote, as were also Resolutions Nos. 5, 6, 7, 8 and 9. Reports of Standing Committees were not heard in detail but were referred to the Secretary for printing in the Transactions. A letter regarding the preservation of grasslands, addressed to the Academy by Professor Victor E. Shelford, was read; no action was taken regarding it, other than to refer it to the Committee on Conservation. The meeting was then adjourned until the next Annual Meeting of the Academy.

3. REPORTS OF THE TREASURER AND THE COMMITTEE ON AUDITING

(a) Report of the Treasurer for the Year May 1, 1945 to April 30, 1946

Receipts

Balance on hand April 30, 1945		$ 1,429.73
Dues and initiation fees		762.60
Research grant by the A. A. A. S.		206.50
Interest from Forbes and Meyer real estate		13.50
Interest from U. S. Savings bonds		5.00
Libraries, subscriptions		2.00
Sale of Transactions		1.00
Junior Academy funds:		
Dues	$ 20.80	
Sustaining members	110.00	
Sale of pins	7.75	138.55
Total Receipts		$ 2,558.88

Expenditures

Section Chairmen's expenses		$ 20.33
Postage, Treasurer's office		16.00
Postage and transportation of Transactions		41.81
Expenses of Secretary's office		109.24
Conservation Council Representative's expenses		5.87
Corporation registration		1.00
Research grants		
C. L. Bieber	$ 50.00	
Mary Gojdics	56.50	
C. Clayton Hoff	50.00	
K. Lucile McCluskey*	50.00	206.50
Secretary, honorarium		100.00
Editor, honorarium		150.00
Stenographic assistance, Secretary (check outstanding)		33.58
Cash balance		1,602.79
Total Expenditures		$ 2,558.88

Statement of Resources

Balance in Commercial National Bank of Peoria, $1,636.37, less outstanding check for $33.58	$ 1,602.79
Certificate of Interest No. 13 for Forbes Building, Chicago, for an aggregate principal amount of $300. *Value unknown*	0.00
Certificate of Interest No. 15 for Meyer Block Leasehold, Chicago, for an aggregate principal amount of $300. *Value unknown*	0.00
United States Savings Bonds, Series G	200.00
Total Resources, in excess of*	$ 1,802.79

* Although the value of the Certificates of Interest listed above cannot be determined, the Academy received $13.50 in interest payments from them during the current year.

Membership.—The membership of the Academy consists of 60 life members, 77 new annual members, 19 sustaining members, 532 members paid up to and including the year 1946, 57 members one year in arrears, and 50 members two years in arrears. The membership is 795.

During the year 4 members have resigned, 6 have died, and 21 have moved, leaving no forwarding address.

Respectfully submitted,
(Signed) John Voss, *Treasurer*

(b) REPORT OF THE COMMITTEE ON AUDITING

May 1, 1946

To The Illinois State Academy of Science:

Your Committee on Auditing respectfully submits the following report:

We have examined the records of the Treasurer for the year May 1, 1945, to April 30, 1946, and find them correct. The present financial status of the Academy is as follows:

Cash on deposit with the Commercial National Bank of Peoria	$1,636.37
Checks outstanding	33.58
Cash balance	1,602.79
Series G, U. S. saving bonds, 2	200.00
Meyer Block Leasehold Certificate No. 15, value unknown	0.00
Forbes Building Certificate No. 13, value unknown	0.00
TOTAL ASSETS	$1,802.79

Respectfully submitted,
Committee on Auditing,
(Signed) A. G. ADAMSON
W. W. GRIMM
J. P. ELLIOTT

(4) REPORT OF THE COMMITTEE ON HIGH SCHOOL SCIENCE AND CLUBS

The committee met in Normal, Illinois, February 9, 1946, in Milner Libary. Present were John C. Chiddix, Roy E. Diveley, Miss Blanche McAvoy, J. Emmert Young, Ralph U. Gooding, and Mrs. Mary Creager.

Mr. Chiddix suggested that we have a smaller sized Junior Academy certificate printed for local Junior Academy meetings. These are to be furnished free to club sponsors. On a motion of Professor Gooding, the suggestion was adopted.

Miss McAvoy's motion was passed requiring notebooks, radio notebooks, and news letters to be sent to the chairman of judging in advance of the state meeting, so there would be time for fair consideration in judging these.

Plans were discussed for the spring meeting. Several suggestions were made regarding the afternoon program.

At the Sponsor's Meeting at Normal, May 3, 1946, it was suggested that the method of entering exhibits he simplified. Final decisions will be made at the Committee Meeting in the fall.

The subject of adding another entry in the form of a research problem in heredity was brought up by the general chairman. This problem will be under the direction of Dr. Clarence P. Oliver, Director, Dight Institute of Human Heredity, Minneapolis, Minnesota. A motion was passed to offer Junior Academy members an opportunity to work on the project. A system of judging and awards for this will be worked out later.

Eight clubs reported local Junior Academy Science meetings. These meetings give sponsors an opportunity to select exhibits to be taken to the state meeting and students a chance to show their work locally. Sponsors reporting local meetings were: Mrs. Nadine Dungan, Sarahsville Searchers, Golconda high school; John C. Chiddix, Community High School Science Club, Normal Community high school; Mrs. Ruth Barchelt, Flamingo Club, Chester high school; Mrs. Mary Creager, Ferreters, Chester high school; Miss Ann Dittlinger and Oren King, M. T. H. S. Science Club, Milford Township High School; G. S. Porter, Chemistry Club, J. Sterling Morton High School, Cicero; L. W. Johnson, Physics Club, J. Sterling Morton High School, Cicero; Miss Mildred Parezik, Biology Club, J. Sterling Morton High School, Cicero.

During the year an interesting exchange of Junior Academy materials has been carried on with other states through the cooperation of Science Clubs of America. Much helpful information has been received from "SCA."

The Illinois Junior Academy of Science now has a membership of 53 clubs with an enrollment of 1400 students.

About 1500 pieces of Junior Academy mail have been sent this year, including news bulletins, Yearbooks, letters, and cards.

The annual meeting of the Junior Academy was held in conjunction with that of the Senior Academy at Normal on May 3 and 4 and was attended by 350

high school students from 30 schools; 170 exhibits were placed on display and judged during the meeting. Awards of Junior Academy certificates were presented to the winners. Outstanding awards winners in the various divisions received special Senior certificates.

From recommendations sent in by club sponsors the following student officers were elected for 1946-47:

President: Dick Johnson, Hitchcock Junior High School, Galesburg.

First Vice-President: Evelyn Holonyak Edwardsville High School Science Club, Edwardsville.

Second Vice-President: Betty Zimmers, Sarahsville Searchers, Golconda High School.

Secretary: Marzie Cary, Bomb-A-Toms, Immaculata High School, Chicago.

Honorary Members for the A. A. A. S.: Betty Lee Warnack, Decatur High School, Decatur.

Billy Wakeland, University High School, Carbondale.

(Signed) Mary Creager,
General Chairman

5. REPORT OF THE COMMITTEE ON AN ILLINOIS JOURNAL OF SCIENCE

May 1, 1946

To The Illinois State Academy of Science:

The Committee has no formal proposal regarding the launching of an "Illinois Journal of Science" to make at this time. Readjustments to peace have brought many uncertainties, such as paper shortage, printing difficulties, drains on institutional budgets due to heavy enrollments, clerical help, and suitable quarters. These are factors that make the immediate venture of establishing a journal for the Academy seem impracticable at the present time.

It does appear, however, that the establishment of a journal, as an organ of the Academy, is worthy of our rather serious consideration. Such a journal would add prestige to the Academy, allow for publication of many articles of interest to scientists in Illinois and elsewhere, provide a valuable source of exchanges, and perhaps help to unify the different branches of the Academy.

Such a journal cannot, of course, be financed without aid from outside. Although our annual dues might very properly be increased somewhat if a subscription to the journal were included, this would not be ample to publish a journal. In the state of Ohio, for example, the *Ohio Journal of Science* is subsidized by Ohio State University by an agreement through which the University receives all the exchanges and adds them to the University library. Such institutional or state aid, or other source of funds, would seem to be necessary before provision could be made for a decent journal.

It is recommended that the matter be studied further and that a report be made to the Academy at its next meeting.

Respectfully submitted,
Committee on an Illinois
Journal of Science,

(Signed) L. H. TIFFANY, *Chairman*
A. E. EMERSON
J. C. MCGREGOR

6. REPORT OF THE COMMITTEE ON RESEARCH GRANTS

During the past year 550 members of the Illinois State Academy of Science have also been members of the American Association for the Advancement of Science. On the basis of this number, the A. A. A. S. has credited to the Illinois State Academy of Science the sum of $225, which the Academy may use on its own behalf and that of the A. A. A. S. in making grants in aid of research.

Your Committee respectfully reports that, owing to disturbances arising from the war and heavy teaching programs resulting from greatly increased enrollments in the smaller colleges of the state, only one application for a grant-in-aid of research has been received. As this application is a meritorious one, the following grant is recommended:

To Professor W. Malcomb Reid, Head of the Department of Zoology, Monmouth College, Monmouth, Illinois, for the maintenance of a colony of experimental animals to be used

in the study of flukes or other mammalian parasites of the tapeworm group, the sum of $75.00.

The above award leaves a balance of $150 to the credit of the Illinois State Academy of Science, which balance the Academy may award at any time within three years to applicants presenting suitable projects. This sum is, of course, in addition to any future amounts that the Academy may receive on the basis of the membership it has in common with the American Association.

Respectfully submitted,
Committee on Research Grants,
(Signed) ERNEST L. STOVER,
Chairman

7. REPORT OF THE COMMITTEE ON RESOLUTIONS

The committee on Resolutions submitted to the membership of the Academy during the general business meeting held May 3, 1946, at Illinois State Normal University the following nine resolutions.

1) *Be It Resolved*, That the Illinois State Academy of Science urge the Legislature of the State of Illinois to stimulate and support scientific research throughout the state, particularly in the small colleges, teacher's colleges, and high schools.

2) *Be It Resolved*, That the Illinois State Academy of Science approve the principles expressed in the present Kilgore-Magnuson Bill, S. 1850, and take all practicable steps to facilitate the passage of this bill through Congress.

3) *Be It Resolved*, That the Illinois State Academy of Science express great concern over the possibility of the destruction of our civilization through war, and urge our government to take measures which will facilitate the organization of a world government devoted to the prevention of international war and to the welfare of all peoples.

4) *Be It Resolved*, That the Illinois State Academy of Science approve the most recent version of the McMahon Bill incorporating civilian control over domestic policy on atomic energy with a military liaison board.

5) *Be It Resolved*, That the Illinois State Academy of Science approve energetically the report prepared by the Secretary of State's Committee on Atomic Energy as a beginning toward international cooperation for the effective control of atomic energy.

6) *Be It Resolved*, That the Illinois State Academy of Science deplore the action of our nation in draining prospective research students from our institutions of higher education, and urge that research in the United States be stimulated in all possible ways in view of its contribution to our national welfare.

7) *Be It Resolved*, That the Illinois State Academy of Science urge the Legislature of the State of Illinois to continue to promote the construction of a new State Museum Building. The need of the Museum for adequate housing, which has long been recognized, becomes more acute daily.

8) *Be It Resolved*, That the Illinois State Academy of Science express sincere thanks to the officials and staff of the Illinois State Normal University for facilities and courtesies extended to the Council and Membership for the seasons of 1945 and 1946.

9) *Be It Resolved*, That the Illinois State Academy of Science express appreciation to the city officials and the people of the city of Normal for courtesies and conveniences placed at the service of the members of the State Academy of Science.

These resolutions were considered individually and were passed, in the forms given above, by majority or unanimous votes of the members present.

Respectfully submitted,
T. T. QUIRKE, *Chairman*
CLARENCE BONNELL
J. C. MCGREGOR